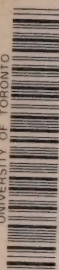


SISAL

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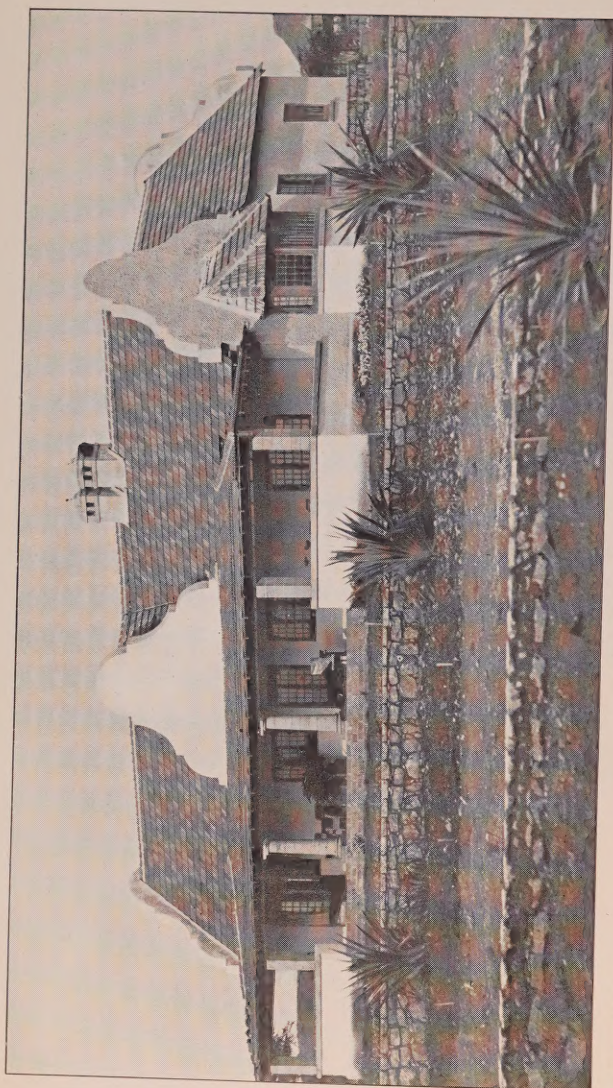
SISAL

Production and Preparation



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By courtesy

A Sisal Planter's Home in Kenya.

Dept. Agri., Nairobi

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SISAL

PRODUCTION AND PREPARATION

COMPARATIVE NOTES ON OTHER FIBRES

THE QUESTION OF PANAMA DISEASE

Edited and brought up to date by

9 vol 10
H. HAMEL SMITH

Editor, "*Tropical Life*,"

Member, Joint East African Board

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FOREWORD

By

HAROLD H. MANN, D.Sc.

WHEN I took up the study of sisal hemp about twenty-eight years ago, with a view to its use as an alternative crop to tea in the Indian tea districts, especially on the land unsuitable for the principal crop of this area, I found it extremely difficult to get hold of full and authentic information on the subject of its cultivation, its extraction or its preparation for the market. Now, so many years later, it is still not easy to find out data with regard to the crop and its difficulties, the exact conditions under which it does best, the yield per acre which can be expected under various circumstances, the length of life of the sisal hemp plant when it is regularly cut for fibre and how best to secure the permanence of the plantations, and so on. And I think that the very best thanks of those interested in the crop, which has already proved to be a very profitable cultivation in several tropical and semi-tropical areas, are due to the editor of this book for bringing together, from many scattered sources, the best information available on the subject.

The present publication will serve to show how far we still are from having, in an available form, information on many of the points which new venturers into this cultivation will wish to know, and how many matters, to which little attention has hitherto been given, will loom prominently in any very large scale development of the product. Such, for instance, is the question of the disposal of the enormous amounts of highly fermentable waste from the factories—and I

am very glad that this matter has been discussed, and the possibility of using this waste as a source of alcohol placed before those interested in the subject.

There is little doubt that the cultivation of sisal hemp is likely to extend in the future, as the value of the fibre becomes more and more realized in the cordage trade of Britain. So far, the only British colonies which export really large amounts are Tanganyika, Kenya and Nyasaland, where cultivation and export are advancing by leaps and bounds. But there are very many other areas where cultivation is at least as suitable.¹ And as the already increasing popularity of sisal hemp has been one of the outstanding features of British cordage manufacture in the present century, it would seem that anything which places the best information, from whatever source, before the public in an available form, is highly to be desired. I trust that the present book, compiled with great enthusiasm by the editor, Mr. H. Hamel Smith, will serve the purpose.

Harold H. Mann

¹ See Dr. Ernest Goulding, *Bulletin of the Imperial Institute*, vol. xxii (1924), pages 39-55, in which several centres are mentioned besides those discussed in the present book.

Details of Dr. Goulding's article will be found in the Bibliography at the end.—(H. H. S.)

INTRODUCTION

WHILST the paper, *Tropical Life*, which I founded in 1905, and have been associated with ever since, has been running for nearly twenty-five years, it is easy to see from the bibliography at the end of this book, how little, if any, information has been published concerning the cultivation of sisal, and the preparation of its fibre for market since about that date, when Major A. J. Boyd, of Queensland, issued the third edition of his book on sisal in 1910, and Dr. Harold Mann and Mr. Hunter drew up and published their well-known report in 1906 on Sisal Cultivation in India. The publication of these two works only seems to have whetted the appetite of the public for information on the subject, and at times they have come in dozens for copies when, so far as could be ascertained, the supply became exhausted soon after the above reports or books were issued. How many copies were printed cannot be stated, but probably my firm alone has had orders amounting in the aggregate to hundreds of copies for "a reliable book on sisal growing" when no such book was procurable.

Dr. Mann himself seems to have noticed the lack of freshness in the news to date of the sisal world as, after a cursory view of the book in the making, he wrote that he "was astonished that so little progress has been made in our knowledge of the sisal plant and its behaviour. There still does not seem to be very much more definite information regarding the length of life of the sisal plant. The records as to yield are also far too indefinite, but those who talk of $2\frac{1}{2}$ to 3 cwt. of fibre per acre must be laying up

trouble and disappointment for themselves and their clients."

Since the war, and even towards the end of the war, when the price of the fibre was at a high figure, several score of men, many of them in uniform, came with requests for copies, and when their demands could not be satisfied, they sat down and took such notes as could be given them on the subject. At that time it seemed as if this interest in the matter would not last, for it rather betokened that a company-promoting epidemic had spread over London, and this I did not feel inclined to encourage. Whether this was the case or not, the inquiries and the disappointments have continued until to-day, so I started to make the necessary arrangements to obtain permission for reprinting these much-coveted reports on the subject, and am glad to say that success has crowned my efforts.

It is, however, with great regret that I have to say that on the very day when I sat down to write to Major Boyd in Queensland to suggest that his report be republished, or such sections of it as were thought best, I got news of his death from an obituary notice in the *Queensland Agricultural Journal*, from which notice I have made the following quotations in order to place on record on this side some account of the very useful and gallant career of one of the ablest men that Queensland's agricultural industries have been associated with.

"Many expressions of regret," wrote the *Queensland Agricultural Journal*, on July 1, 1928, "at the passing of Major A. J. Boyd, F.R.G.S., who was editor of this journal from 1897 until his retirement in 1921, have been received together with widespread evidences of the appreciation of his worth and work."

According to the *Brisbane Courier* of June 16, Major Boyd, soldier, sailor, schoolmaster and journalist,

was an enthusiastic soldier, very proud of the fact that three of his lieutenants in the Brisbane Garrison Battery, when he was in command, all became distinguished soldiers, viz., the late Major-General Sellheim, General Foott, and General Coxen, whilst General Sir Brudenell White also received some coaching from Major Boyd for his military career.

The above, of course, only touched on our old friend's career as a soldier. To me, personally, he was always a careful student of sisal production in all its aspects, and one who was very willing to pass on to others the results of his investigations, even when carried on at considerable cost to his leisure and personal comfort. When one thinks of all that the late Major Boyd has done since 1897, to go back no further, it is at least pleasant work to be able to make use of his knowledge with regard to sisal planting and place it on a more widespread basis than it would have enjoyed if left alone in its original publication, since there are no more copies left for sale and distribution.

In face of this report of Major Boyd's death, application was made to the offices of the Queensland Government in London, and the Chief Commissioner was good enough first to write out to Brisbane for permission to reprint the report, and later, to cable out for a reply, in order to save time. The return cable being in the affirmative, all that then had to be done was to await the answer from the Indian Tea Association in Calcutta to see whether we could publish Dr. Harold Mann's and Mr. Hunter's report at the same time. This permission we received subject to the approval of Dr. Mann himself, who, having retired from service in India, we traced to the Woburn Experimental Station in Bedfordshire, where he was still hard at work carrying on experiments. From there came a most encouraging answer with the

following paragraph: "As regards my publication on sisal hemp, I shall be very glad if you will use it in any way you think best," and so, armed with this double permission, we at once proceeded in the work of compiling the coming book.

Those of us who are watching Dr. Mann's career, for he was still a comparative youngster, probably about 56, when these lines were being typed, must remember what a very thorough training he had before he started on his investigations as a sort of plaything in the midst of his more serious work for the Indian Government and the Tea Association. Dr. Mann studied at Leeds and took his degree at Manchester in 1892, and at the Pasteur Institute in 1893-94, then he came to England and was at Woburn, as he is to-day, in 1898, whilst in 1900 he went to India as the first Scientific Officer of the Indian Tea Association. The work that he has done since then, and the reports that he has drawn up and published would take too long to enumerate here, but I would like to mention his book on "The Pests and Blights of the Tea Plant," which he published in collaboration with Sir George Watt in 1903. When you read, therefore, further on, what Dr. Mann has to tell us on sisal, you feel that you are studying the advice of one who knew his subject thoroughly, and who, the same as Mr. Hunter, did not make statements unless he was sure that they were correct.

Of the two reprints, we are starting with that by Dr. Harold H. Mann (then only M.Sc.), Scientific Officer to the Indian Tea Association, and Mr. James Hunter, manager of the Dauracherra Fibre Estate, and then go on to the report drawn up by the late Major Boyd. In both cases the original spelling remains, as I am not competent or desirous to comment on the correctness of such words as *Fourcraea*, *Furcraea* or *Fourcroydes*, nor can I settle the diversity of

opinion as to which is the correct botanical name of the several Agaves so much cultivated and discussed. Besides, I am not "out" to bring together a scientific work on the subject, but to help those of my friends and readers who, being interested in fibre production, are very anxious to turn out best goods to benefit the world at large at the lowest cost and, through that, at the biggest profit possible to benefit themselves.

Writing to wish me "good luck" with the venture, Mr. Albert Howard, Director, Institute of Plant Industry, Indore, India, sent the following statement in his letter. Here please note the six words printed in italics, those fatal six over which so many words have been used in the past and will, apparently, be used time and again so long as the cultivation of sisal is carried on:—

SISAL HEMP.

Extract from "Crop Production in India," 1924, pp. 143-144.

"In the early years of the present century, a good deal was written about the prospects of sisal hemp in India. Several plantations were started about that time, on certain tea estates in Assam, in Chota Nagpur, and in the United Provinces. The species most suited to Indian conditions was found to be *Agave sisalana* Perrine. The conditions necessary for success were studied in detail by Mann, when Scientific Officer to the Indian Tea Association. The results of his investigations were published in 1904 in a pamphlet entitled, "Sisal Hemp Culture in the Indian Tea Districts." The plant did best on good well-drained land, where the rainfall is well distributed, so that there is no check in growth. *Suckers gave better results than bulbils.* The cultivation is only suitable for the capitalist in areas of India like

Assam, where suitable land is available at a small cost and where there is sufficient rainfall. Since 1906, practically nothing has been published on the subject. The cultivation has not been taken up by the people, while the area on the Assam estates has greatly diminished. There is, however, one locality in the Central Provinces where sisal is grown on a large scale. In the Kawadha Feudatory State adjoining Bilaspur, the fibre is made into ropes and cloth. The crop does not appear to be popular, as the juice of the leaves produces eczema on the arms and legs of those engaged in the extraction of the fibre."

In answer to an inquiry from a director of one of the leading East or rather Central African development companies, as to whether the production of sisal from bulbils or suckers gave the best results, and if my records included any information on the subject, the following reply was sent:—

"Your letter of April 11, 1928, has duly come to hand. Truly can it be said that the world never changes. I am sure that it is quite fifty years ago since I heard the word bulbil for the first time, and thought it was a bird (the bulbul or Persian nightingale). I caught the name in the midst of an excited debate going on in the dining-room at home as to whether 'bulbils or suckers' were the best to start a sisal plantation going. As I sit here to-day I really cannot say which side is supposed to have won, all I do remember is an agreement was arrived at that plants grown from bulbils tend to pole earlier than do those which come from suckers. Then, as ever after, my curiosity being aroused, youngster that I was, I asked many questions and knew what bulbils and suckers were before I retired to roost that night.

"If you do not know the bulletin or report published by Dr. Harold Mann and Mr. James Hunter, I might say that even these authorities tell us that

'whether bulbils or suckers are best is quite a moot point.' In Yucatan, suckers are, or were, exclusively used; this certainly was the case at the beginning of this century, and bulbils it would seem are rarely, if ever seen, because the pole is cut out as soon as it begins to grow. Dr. Mann agrees that suckers seem to represent the best means of production, and quotes Sir Daniel Morris, a great authority on the subject, when he was on 'active service,' who said 'I am of opinion that pole plants, i.e., bulbils, produced as an expiring effort on the parent plant, are not always calculated to produce such robust plants as can be claimed for suckers, at least, they are not so likely to be so when derived from plants whose leaves are periodically reduced when cut for fibre purposes. It would be well to investigate the matter experimentally, and this could be done by planting suckers and pole-plants or bulbils side by side, and watching the result, but,' concludes Dr. Mann, 'the use of bulbils ultimately will probably be given up entirely in favour of suckers, or very nearly so. It was only, as in the case of India, where many plants were required immediately, that bulbils were so freely used.'

"Concerning the tendency to confuse bulbs and bulbils, thinking them to be one and the same, only incorrectly spelt; may I add that, so far as I know, bulbs are suckers, as you will find very plainly stated on p. 171, ex Mr. Frank Conter's bulletin, written in Hawaii, where he says, 'When the plants have become firmly established in the field, the mainstalk throws out underground runners or rhizomes. The point of such a runner reaches the surface, beginning with the second year, and forms a bulb. *This bulb is known as the sucker, or shoot of the plant*, and it takes roots and obtains nourishment through the runner from the old plant, and also through its own roots.' This statement is of interest in comparison with Sir

Daniel Morris' claim that suckers must have more strength and life in them, being produced in the way they are, whilst pole plants or bulbils come as the dying effort of the old plant."

Whilst dictating these lines, one is inclined to ask: What will the future bring us with regard to the production of sisal, either through natural evolution or the wish of the careful planter to produce the very best fibre he can at the fairest (if not always the lowest) cost to everyone concerned? Again, what can we look for, if the pressure of competition with other fibres (striving to supply the needs of those markets which to-day seem fully satisfied with the sisal of commerce as its raw material) tends to thrust sisal against the wall? In these days nothing stands still, and the favourite or the indispensable raw material for the time being may find itself thrust aside with but scant notice, for a rival at any moment. Given a genius, a restless brain and some metal, and you never know what will happen. The course of a market, on account of the invention of a new machine, may be entirely changed in less time than it would take to describe the revolution. Sisal growers, therefore, must always keep their eyes open for the unexpected to happen, whilst plodding along full of confidence that they are quite up to date in their appliances and methods, with which to satisfy the "orders of the day."

The future of sisal production must lie always, if not in the direction of the big man or company, at least in the direction of the big factory. As Major Notcutt warned us in 1923¹, for a sisal estate to succeed, production costs must be kept down, and to keep your costs down, the estate must be run on a large scale and the factory kept fully employed.

¹ "Sisal Economics and Technics," by Major L. A. Notcutt, M.C., Assoc.R.S.M. With seventeen illustrations. Price 7s. 6d. net.

Your transport facilities must also be up to date and of course your soil and climatic conditions in all ways suitable. "Five to seven years from the time of planting in the estate will see the commencement of poling. The richer the soil the shorter the life," and as the leaves do not mature—for fibre—any quicker, if as quickly, on the richer soil, but yield fibre usually at three years of age, it is easy to realize what a larger amount of profit can be obtained if the soil and climatic conditions tend to delay poling rather than to hasten it."

Leaving Yucatan out of the running, centres like British East Africa, with its increasing number of white settlers, may find that, as with cane-sugar production, sisal farmers each with such an area as they can "handle" with ease will prove the most remunerative, i.e., the least costly way for all concerned. Such men, being their own supervisors and managers, save the cost of those—the highest paid salaries, and with the central factory taking all their crop, preferably "in the field," the farmer has no anxiety as to the marketing of his crop, and can devote all his mind and time to improving his methods of production. Such a central factory could well be run on co-operative lines, with some outside money to bring in the salesmen's experience and capital, the whole being managed by a joint committee, part of whose work would be to see that the right class of sisal was produced in the right way, whilst those in the factory saw that its methods for preparing the sisal for market left no cause for complaint.

Put briefly, therefore, it seems likely that the future production of sisal, outside of Yucatan—whose views in connection with labour conditions are not in accordance with our own—lies in the direction of small growers, large factories kept constantly busy, mechanical transport everywhere,

up-to-date machinery, especially with regard to drying the fibre and strict attention to the cost of transport, first to the shipping port and then across the five seas to the distributing centres and final consumers. I have bought, probably about 1889, the best quality of sisal cordage, spun dry to keep it as white as possible, at 25s. cwt. f.o.b., with the fibre around £18 ton (against £15 in 1895) and the Latin-American customer asked if it could not be done cheaper. Who would ask such a question to-day, or could have done so, and remained at large since that date when prices started to rise and have remained above 25s. (for cordage) ever since? All the same what has happened once can happen again, so be sure and run your estate and factory on "best lines" and be ready for any emergency.

With regard to the preparation of the fibre, it may be of use to add that in July, 1905, after a somewhat lengthy correspondence with the American fibre experts—who were discussing and comparing the preparation of Philippine manila fibre with those known as maguey, sisal, or other kinds—the question of a possible portable machine to be run out on to the estate, came uppermost, and finally took the form of a letter, from which the following are extracts:—

"Men who have given the subject careful attention, and who have travelled over the fibre-producing areas in the Philippines, seem to agree that a successful portable machine for manila hemp must meet the following requirements, some of which, like a carabao-drawn machine, are quite unthinkable to-day:—

"(1) It must be small enough and light enough to be at least as portable as the ordinary grain-threshing machine; an effective machine that can be drawn by a single carabao, or water buffalo, being preferable.

"(2) The machine must be run with a compara-

tively small amount of power, as of course the power plant must accompany the machine. The manila or abaca plant is chiefly grown in scattered localities in mountain regions, and as the fibre must be cleaned within a short time after the plants are cut, it is not practicable to have large central works to which the heavy leaf sheaths must be shipped.

“(3) All parts of the machine coming in contact with the fibre immediately it is cleaned must be free from steel or iron surfaces which would discolour the fibre.

“(4) The distance from the scraping knives to the grip holding the leaf or fibre must remain practically constant and not exceed eight or ten inches, as otherwise there is likely to be an increasing and considerable strain on the fibre which will result in much loss.

“(5) Manila leaf sheaths, like the leaves of the Agaves, i.e., sisal, must not be steeped before the fibre is extracted, since steeping fibre-producing leaves discolours and weakens the fibres.”¹

Surely the world has moved very far since then. Whether a fibre decorticating machine can yet be run out on to the field or not, does not prevent one from realising how steam tractors and other improved and more speedy methods of transport have been introduced, whilst the use of electric power has advanced and improved matters to an incredible degree since the above letter was written.

In November, 1905, I was also busy discussing the use of banana fibre for paper-making and the possibility of utilising the abundance of objectionable liquid that the extraction of this fibre calls into being for the production of industrial alcohol. Later, I tackled sisal waste and its equally, or still more

¹ Can one reconcile this in any way with the recent statement, see pp. 203 *et seq.*, on the retting of fibres?

objectionable, because dangerous, fluid, for the same purposes ; but of that, more anon.

One word of warning may be necessary. Form no definite conclusions until you have mastered the contents of the entire book. Sisal, more than with most crops, seems to have been brought into this world, *inter alia*, to set people about the ears and to cause discussions and debates interminable. It has been so in the past, it looks as if it will be so in the future. Be wise, therefore, read what all have said, and then form your own conclusions as to what is likely to prove best for just the soil and climatic conditions amidst which you find yourself. This book as published is not intended to be an infallible guide as how to carry a sisal estate on to complete success, it has been compiled and published merely to enable those who study its contents to remember what has been written by others on the subject during the present century and to compare what has been said with what their own experience has to teach them nearly a quarter century later.

After some hesitation, I have decided to cut out any reference to pests and diseases, firstly, because so far they do not seem to have been serious, and secondly, because such information as is to hand seems scrappy and "unfinished," leaving you uncertain whether to worry about them or not.

Critics have already asked why I have not included a page or two on "costs of production." To this the answer is that the ideas of planters of all crops as to costs are on a parity with anglers' tales regarding the "tonnage" of fish that they have caught in a day ; all are correct in the minds of those who tell the tales, but since it is far too seldom for the bulk of us to expect to go and do likewise, it is best to cut such a section out altogether. Costs must vary every time on account of location, ability to handle the produce, facilities

of transport, &c. Even the tables on pp. 160-163 have been pulled to pieces. "Where is the interest on capital?" "What has been allowed for a sinking fund?" "Baling 80 ft. to the ton (p. 163), why, who is content with that?" "Baling (p. 162) at 5s. 6d. ton, does that include the iron hoops?" and so on. It is far better therefore not to generalize on such matters and to leave each estate owner, actual or potential, to work out his own chances to produce at a fair price according to the advantages or drawbacks with which he is, or is to be, surrounded.

The one section that has not come up to my hopes and expectations is that contained in Chapter XII on "Alcohol from Sisal Refuse." Whilst only expecting to set the ball rolling for others to deliver inside the goal, I am not too sure whether the ball has been started at all. One can only hope it has, since satisfaction has been expressed that the section is included. In any case it is sure to attract attention, and what is ridiculed one year is often run after and absolutely worshipped a year or so after, both the inventions and their inventors. Meanwhile this can well be remembered; the demand for and consumption of alcohol far exceeds the knowledge of most of us. Next to water, Dr. Henry Arnstein tells us, discussing the demand for alcohol in America, when addressing the heads of the American Chamber of Commerce at Cuba, at the American Club, Havana, on March 6, 1929, alcohol is the most generally used solvent; 35 million gallons annually go to prevent water freezing in the radiators of automobiles; some 15 millions go in cosmetics, tobacco takes 1,500,000 gallons, the manufacture of felt hats 1 million gallons. The production of gasoline (in America) has moved from 291 million gallons in 1904 to 15,120 millions in 1928, and the ratio of increase for this and all liquid fuels is beyond belief to the lay mind. The

tropics are forging ahead in the use of locally produced alcohol fuel in place of imported gasoline and petrol or motor spirit generally, Manila and the Philippine Islands, Brazil, or natalite in South Africa, whilst Germany is mixing her benzol and synthol with alcohol to such an extent that her alcohol consumption for fuel purposes has just increased 425 per cent. in a year. If America and Europe can seriously sit up and discuss increased outputs of cereals and potatoes within their areas, already so overcrowded (at least in Europe), surely the idea of the production of alcohol from huge quantities of three waste products (sisal, manila, banana), classed as a nuisance, deserves more attention than it is receiving at present. This book I hope will do good in the sisal world generally; if it attracts serious attention in the times to come, if not in the immediate future, to the possibilities of sisal, banana and manila fibre-waste as possible sources of alcohol, then surely much good can be looked for to the consumers of alcohol and to the producers of fibre and bananas alike.

As we stand to-day, no one would care to say that we have reached finality in the matter, and the writer for one certainly believes that with the diversion made from the old methods, we can look for quite considerable changes for the better during the next ten years, changes that will appear so simple when actually worked out that everyone will be surprised that they did not think of them before.

Grateful thanks are due to the Queensland Government, both in Brisbane and in the Strand, London, and to the Indian Tea Association in Calcutta, and Mr. Pease, the Secretary, and the Council in London, for permission to reprint the reports by Major Boyd and by Dr. Mann and Mr. Hunter. In both cases, those in charge in London have shown a willingness to help that I have much appreciated. Looking upon

Sir Daniel Morris (who, one is glad to know, is still going strong) as the Father of the modern school of sisal production, I wrote telling him that an up-to-date work on this crop would be appearing, and he at once wrote back saying how glad he was to hear the news and sent us his "blessing on the venture," whilst Dr. Harold Mann writes that he finds the first portion of the book, to do with Production, full of information, and if "I could see pulls of the second part I shall be pleased, as you request, to write a short Foreword for the book. I certainly shall be glad to see the rest of this valuable compilation."

Further acknowledgments and thanks are due to others, especially those in East Africa who have sent liberal supplies of photographs and data, all of which have been used and much appreciated. I should have liked to express such appreciation in detail, but time is short. I tried very hard to get the book out before that Day of Days for all good East Africans, viz., the Annual Dinner of the East African Dinner Club, which was honoured this year by the presence of the Prince of Wales. The receipt of important matter concerning the utilization of sisal refuse caused me to keep the book back for another month.

H. HAMEL SMITH,

Editor "Tropical Life."

LONDON: 5, GREAT TOWER STREET, E.C.3.

July 31, 1929.

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Reproduction of the drawing of a Sisal Seed Capsule
illustrated by Mr. Frank Conter in his *Bulletin* as
described on p. 201.

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Not Sisal, but *Yucca gloriosa* (?) in bloom at Bexhill, England, July, 1929.

The above attractive picture does not represent a sisal plant poling, but has been included at the end of the story as a souvenir of the kindly help received by the author of this work from the owner of the plant.

SISAL

CHAPTER I.

*INDIA*¹

By Dr. HAROLD H. MANN

Scientific Officer to the Indian Tea Association

AND

JAMES HUNTER

Manager of the Dauracherra Fibre Estate

THE possibility of utilizing in a profitable manner a large part of the lands now lying waste and uncultivated in the Indian tea districts is one which has been prominently brought before the public on many occasions in the past. In many, if not in most cases, the waste land is, however, of a type which seems as if it can be better developed by the ordinary ryot settler than by the planting community. But when all such land has been settled, there remain vast tracts of country, unsuitable for ordinary native culture, not perhaps rich enough for tea under present conditions, and yet which ought to be cultivated, and, under certain crops, quite capable of being so. For the development of such land the growth of agave and similar fibres, known to commerce as "sisal hemp," "Mauritius hemp," &c., has been suggested, and now that the market for these materials seems to have reached a fairly stable condition, it is time to consider by what methods such culture can be carried out, what

¹ Published in 1904 (see close of Introduction).

is the equipment required, and what are the commercial prospects of a venture in this direction.

HISTORY OF AGAVE FIBRES.

The whole of the group of fibre plants we are considering is of American origin. Not a single representative of the group is native to India, or even in the Old World, and all have, in fact, been introduced from the Western Hemisphere. There they are indigenous to almost all parts of tropical America, over a broad belt of about 30° on either side of the equator. In spite of their general distribution, however, the commercial production of this class of fibre was until quite recently limited entirely to certain districts in Mexico. The fibre produced was almost all locally consumed, and it was incapable, owing to the difficulty of export, of taking any very important position among the world's fibre supplies. As long ago as 1854, however, nearly a million pounds were imported into New York. In 1838 the best of the Mexican plants was introduced into Florida by Dr. Perrine, and a little later the same type of plant found its way to the Bahamas, a group of West Indian islands to the south of the Florida Peninsula. In both these places the plants introduced grew with great vigour, but in total neglect for many years. Mexico remained, in fact, until the later eighties the sole commercial source of the agave fibres. At that time there occurred a rapid rise in the price and value of the class of so-called white rope fibres (to which those obtained from the agaves belong), chiefly owing to the operations, in America, of the National Cordage Trust, and cultivation was seriously undertaken both in the Bahamas and in Florida, while the culture was introduced experimentally into various other parts of the West Indies. In the slump in prices which followed in 1894-95 much land went again out of cultivation in agave fibre,

and the Bahamas, with some other West Indian islands, and Florida, together with Yucatan, remain practically the sole sources of the fibre known on the market as sisal hemp.

The fibre known as Mauritius hemp has a different history. It is also obtained from an American plant, but was introduced into Mauritius as long ago as 1790, and there, as well as in St. Helena, it is regularly cultivated as a fibre plant. It has shared the ups and downs of the market for white rope fibres, but to-day has an assured position of its own.

BOTANY OF AGAVE FIBRES.

The plants yielding the agave fibres, botanically considered, belong to the order Amaryllidaceæ and are in common parlance known as aloes, although they are not, botanically, aloes at all. Of these there are some 150 species known to science,¹ but the bulk of them have no commercial interest, and moreover many of them have never been introduced to India. But at various periods quite a number have been brought to these shores, either as ornamental plants, or with the idea of forming hedges to gardens, banks to roads, boundaries to estates, or good plants to grow on railway embankments and similar situations. It is in this fashion that the common large blue aloe of the North-West and Central Provinces has been introduced. Near Bombay, and to some extent in the North-West also, a species is commonly known locally as *Agave vivipara*, which has narrower leaves than the former. This last has in fact been used extensively by the Agave Fibre Co. of Powai, Kurla, Bombay, for the production of commercial fibre. Other types of agave plant abound now in many parts of India.

It is not our intention, however, in this report to discuss or describe all the species of agave, possibly of

¹ According to the *Index Kewensis*.

use for fibre manufacture, found in India at present. To do this is, in fact, not now feasible, as it is not easy to distinguish botanically all the types found, except when they flower, which may only take place in from ten to fifteen years. The definite botanical determination of all the species existing in India is for the future, and for professional botanists, but this is no hindrance to the description of the species which have been found most useful as producers of fibre, and there exist enough data now from plants grown in the tea districts themselves to warrant fairly definite statements on the subject. We have been recently reminded, however, by Major (now Sir David) Prain,¹ that we are not warranted in deducing the relative value of the different agaves in India from American experience, and, throughout all that we may say on the subject, it must be remembered that a plant may any day be found whose fibre in America was of little value, but which here in India may prove better than any.

All this group of fibre plants, by whatever botanical name they may be known, possess certain characteristics of growth. Like all the plants of this order they possess long, straight fleshy leaves arising from a common very short and thick stem. New leaves appear from the centre of the plant, and the old ones thus are always on the outside, where, unless cut off, they ultimately die, being replaced constantly from the centre.

After a number of years, varying with the conditions of culture, each plant sends up a straight flowering stalk (termed a "pole") from the centre, on which a vast number of flowers occur. When this poling occurs the original plant always dies. In addition to the production of seeds, as with all flowering plants,

¹ Report, Calcutta Botanical Gardens, 1903-04.

the continuation of the species is secured in a very peculiar manner. From the point where normally a flower stalk would arise on the "pole" there grows a small, young plant termed a "bulbil," which after remaining for some time on the dying poled plant, is disentangled by the least wind or shaking and falls to the ground, where it may take root and form a new plant. These fallen bulbils can be collected, and, as they are very tenacious of life, may be kept without planting for a considerable period and transported to long distances.

The plant has, however, another method of reproducing itself. From the second year after planting, and sometimes from the first year, it throws out root-stocks underground which at intervals produce new plants. These are usually termed "suckers." They may be separated from the parent plant, and used for planting new areas.

The description just given applies to all the fibre plants of the group with which we are dealing. But there are only four, or perhaps five, of these which are at all likely to be used in the Indian tea districts, or which could, on our present knowledge, in any sense be recommended for the purpose. Two of these are varieties of the true sisal hemp of Yucatan and the Bahamas (*Agave rigida*). A third, whose value appears, however, to be relatively very low, is the large blue aloe of the North-West (*Agave lurida*?). A fourth is the narrower-leaved agave of Bombay and the Central Provinces (*Agave vivipara*?). The fifth belongs to a different genus altogether and is the Mauritius hemp of commerce (*Furcraea gigantea*).¹

¹ A plant locally called *Agave americana* has been planted for fibre in one or two places in Sibsagar, Assam. It is not, however, the plant which is usually known by this name and at present it cannot be properly identified. Its fibre is fair, inferior in strength to sisal hemp, and worth probably about £5 per ton less with sisal hemp selling at £30 to £35 per ton.

The question which of these should be planted seems to have intensely agitated all those who have thought of going in for fibre planting in India. But the most sorry part of the whole business is that, except for the true sisal hemp, and the Mauritius hemp which belongs to a different genus and is quite different and characteristic, no one seems hitherto to have been able to define the plant which they suggested for planting. What one authority has called by one name another calls by a totally different name. A leaf was sent to us a short time ago from Assam which had been called *Agave lurida* by high authority, which was certainly different from any *Agave lurida* with which we are acquainted, and a similar state of confusion has appeared throughout. We shall not therefore attempt here to describe any other agave by name than the true sisal hemp (*Agave rigida*), whose characteristics are well known, which can hardly be confused with any other, and which undoubtedly, as grown in Sylhet, produces much the best fibre and contains the largest percentage of it in the leaf of any which have been planted. If any other species is put out on any recommendation, it must be recognized that in ninety-nine cases out of a hundred an inferior fibre will be the result, and that the success or failure of the place is purely problematical. So far as the tea districts are concerned, the areas from which we have deduced the bulk of the facts in this report are planted with true sisal hemp (and Mauritius hemp as above noted) and it must be also recognized that statements of yield, value of fibre, age of yielding, &c., may be quite inapplicable to the other species of agaves.

CHARACTERISTICS OF TRUE SISAL HEMP.

The true sisal hemp of commerce is known to botanists in two varieties, named *Agave rigida* variety *elongata* and *Agave rigida* variety *sisalana* respectively.

The former of these is the principal sisal plant of Yucatan, the latter that of the Bahamas, and the general opinion seems to be that the *sisalana* variety is the best. Plants of the former variety introduced direct into Sylhet from Yucatan have not been very luxuriant, and for the Indian tea districts the *sisalana* variety has, hitherto, proved to be preferable.

This variety may be described as possessed of only a very short trunk, with straight stiff leaves from 4 ft. to 6 ft. long and 4 in. to 5 in. wide. These leaves have a bloom upon them, giving them a blue tinge, but when this is rubbed off they are dark green in colour, much greener than the large common blue aloe of the North-West. The edges of the leaves in a typical plant are smooth, without thorns or with thorns so small as to be hardly noticeable. But this character of thornlessness is an extremely variable one. The young bulbils and plants for the first year of life often, in Sylhet, at any rate, show decided thorns on the side of the leaf which disappear, or nearly so, as the plant becomes older. More than this, it is not at all uncommon for plants raised from bulbils of a thornless plant to possess thorns throughout life, and to be indistinguishable (until the flowering stage) from the Yucatan variety—*Agave rigida* variety *elongata*. The spine at the tip of the leaf is an exceedingly strong one, often twisted, and purplish-black in colour on all the plants.

MEANS OF DISTINGUISHING SPECIES OF AGAVES.

It may be worth while calling attention to the characteristics which should be noticed in the leaves if it is wished to distinguish one species of agave leaf from another, and so determine whether the correct one is being planted. It must be remembered, however, that they apply only to mature leaves; it is, so far as we can tell, impossible to identify a species from

a sucker or a young plant under one year old, and, in any case, the flower has to be obtained in order to be *botanically* certain, though for commercial purposes this is not now necessary with the true sisal hemp (*Agave rigida*). The leaf characteristics in order of importance are perhaps as follows:—

(1) *The Shape and Proportions of the Leaf.* The true sisal hemp (*Agave rigida*) is a narrow, straight, stiff leaf, with very parallel edges from the bottom upward. The mature leaves are rarely more than 4 in. to $4\frac{1}{2}$ in. in width, and twelve to fifteen times as long as broad. The following table shows figures relating to three undoubted leaves of the true sisal plant. I have added similar details for another unnamed agave plant from Assam:—

The difference in character is evident from these figures. In this connection it may be noted that the sharpness of the tip of the leaf varies considerably among undoubted sisal hemp plants, and accounts for the difference between No. 1 and No 3, where with leaves of equal width there is a difference of 1 ft. in length. On the other hand, the unnamed plant is at once seen to be much wider in proportion, the width being over one-ninth of the length, a figure never reached with true sisal.

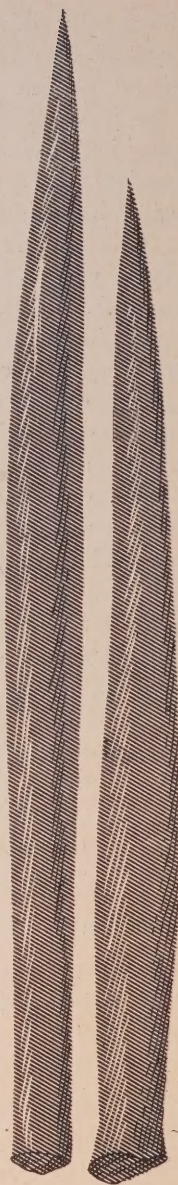
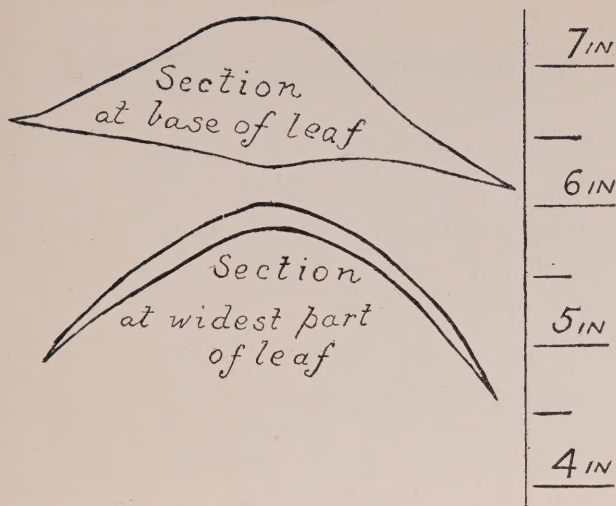
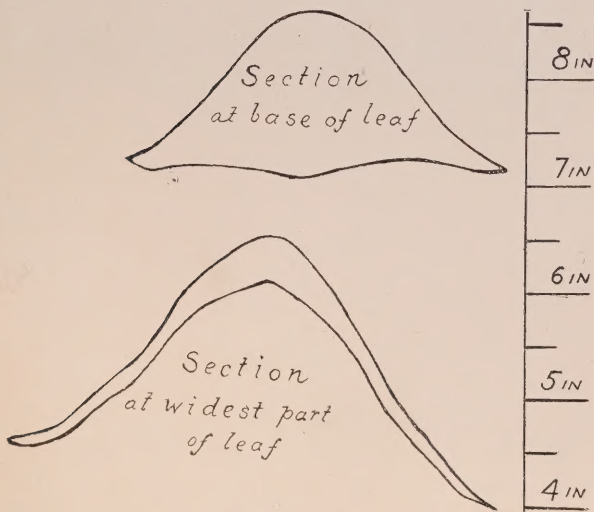


FIG. 1.—Leaves of true sisal-hemp plant (after Dodge).

PLATE I.

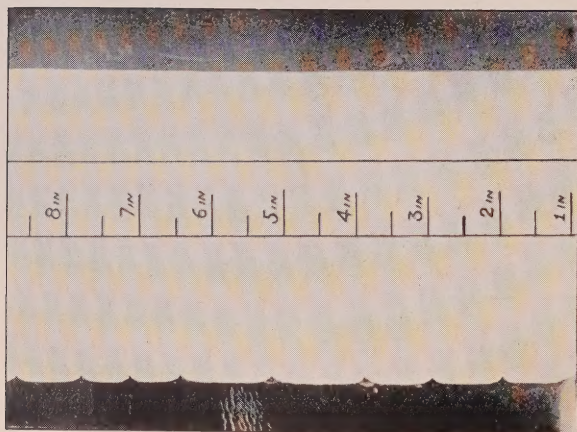


A.—Sections of mature leaf of the true sisal plant.



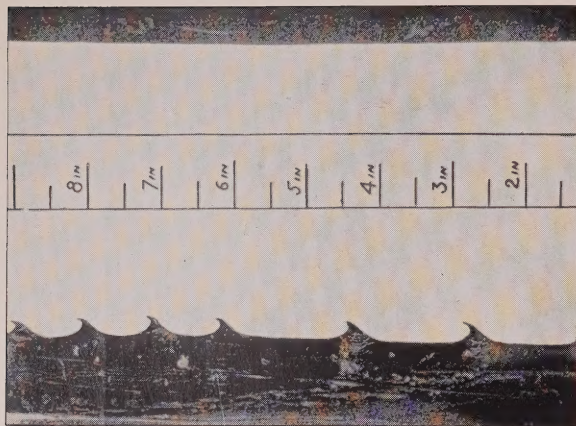
B.—Sections of mature leaf of Mauritius hemp plant.

PLATE II.



A.—The true sisal plant.

Left, edge of leaf of thorny variety ; *right*, edge of leaf of smooth variety.



B.—Mauritius hemp.

Left, Mauritius hemp, edge of leaf showing thorns ; *right*, sisal, showing edge of smooth variety.

	No. 1.	No. 2.	No. 3	Unnamed agave plant from Assam
Length	5 ft. 0 in.	—	4 ft. 0 in.	5 ft. 5 in.
Breadth (at widest part)	4 in.	4 in.	4 in.	7½ in.
Breadth—				
(1) 2 in. from bottom	3⅛ in.	3 in.	2⅝ in.	4½ in.
(2) 6 in. from bottom	3 in.	3 in.	2⅞ in.	4½ in.
(3) 12 in. from bottom	3½ in.	3 in.	3⅜ in.	5 in.
(4) 24 in. from bottom	4 in.	4 in.	4 in.	6½ in.
Breadth—				
(1) 2 in. from tip ...	½ in.	—	1 in.	1⅛ in.
(2) 6 in. from tip ...	1½ in.	—	2¼ in.	3⅛ in.
(3) 12 in. from tip ...	2⅜ in.	—	3¼ in.	6½ in.
(4) 24 in. from tip ...	3⅞ in.	—	4 in.	7½ in.

(2) *The Shape of Section of the Leaf at the Base and in the Widest Part.* If a sisal leaf be cut at the base and in the middle it will give sections similar to those in Plate I, fig. A. The base section is much thinner in proportion to its thickness than is the case with all the other species in India that we know. Thus, to again compare true sisal samples with the unnamed one above, we have—

	No. 1	No. 3	Unnamed
Width at base ...	3½ in.	2⅝ in.	4¼ in.
Thickness at base ...	1 in.	¾ in.	1⅞ in.

The leaf at the widest part, moreover, is about ¼ in. thick in the middle, shows little trace of a thicker central core, and is almost equally thick from side to side. It is, moreover, very flat compared with most other similar plants. Compare it, for instance, with the section of *Furcraea* in Plate I, fig. B.

(3) *The Method of Growth of Plant.* The illustrations show very well the characteristic growth of the leaf of the true sisal plant. Straight from bottom to top; little tendency to turn over until very mature; very vertical and spiky; such are the characteristics of the leaves as they occur on the plant. On other species they often leave the core nearly horizontal, and then turn up straight; they often turn over the tip in a very early stage of growth (as with the common American aloe of our ornamental gardens); they often hang limply from the plant in a very different manner from the business-like directness of the true sisal.

(4) *The Bloom and Colour of the Leaf.* The colour of sisal is, when taken with other considerations, quite characteristic. It is distinctly, when the bloom is present, a greenish-blue leaf, and when the bloom is rubbed off it remains a very dark green colour.

(5) *The Thorns at the Tip and the Prickles on the Side of the Leaf.* True sisal always carries a stout, black, round, often twisted thorn at the tip of the leaf, which is indeed a formidable weapon. The presence of this thorn is no peculiarity of our plant. It occurs equally stout, and equally formidable, on quite a number of other agaves. The typical *Agave rigida* variety *sisalana* has, furthermore, no prickles on the side of the leaf, but prickles often occur in plants obtained from bulbils from individuals with such smooth-edged leaves. When they so occur they are small, slightly turn up, are black in colour, and at not very regular intervals. Plate II, fig. A, shows clearly the edge of such a thorny leaf side by side with the edge of a plain one.

In fact, in distinguishing the agaves too much stress may easily be laid on the presence or absence of side prickles on the leaves. The character seems a very variable one in all species. On account of the special ease of working, the thornless individual plants

are distinctly to be preferred to those with thorny edges.

CHARACTERISTICS OF MAURITIUS HEMP.

The other plant to which we wish to refer as suitable for cultivation in the India tea districts is the Mauritius hemp, *Furcraea gigantea*. It belongs to a different genus altogether from those previously considered, and gives a fibre quite different from true sisal hemp. It is, in fact, chiefly used for entirely separate purposes. The plant itself can never be confounded with any of the agaves. It possesses a much larger and longer leaf than most of them, often reaching 8 ft. in length by 7 in. to 9 in. in breadth. These leaves are further distinguished from the agaves just described: (1) by possessing no strong terminal black spike to the leaves, which merely come to a hardly hardened point; (2) by the thorns on the edge of the leaf, which are large (see Plate II, fig. B) and only occur upward from the base to from half to two-thirds the length, and are quite characteristic in shape; (3) by the colour of the leaf, which is always light green, without a tinge of blue, a fact sufficient to identify the plant at a distance; (4) by the cross-section of the leaf which, while thinner near the edges for the greater part of its length, has all through a thick central core (see Plate I, fig. B). At the base the leaf narrows and becomes almost as thick as it is broad.

Furcraea fibre or Mauritius hemp (as we have already said) has a position of its own in the market. This is indicated by the fact that in recent years the fluctuations in its price have been by no means so great as those of sisal hemp and Manila hemp.

With regard to the relative advantage of these species for planting at the present moment, we would place the true sisal hemp (*Agave rigida* variety *sisal-*

lana) by far ahead of any. We have already indicated that the fibre is of higher value as grown in our districts. Of this there can be no doubt, as specimens actually made in the districts have shown it. Further, the percentage of fibre to leaf is greater than with either of the other plants, an important factor when it is considered that the carting of the leaves into the factory is a large item in the cost of working a fibre estate. The true sisal hemp, grown on suitable and not too rich land, should yield, for instance, 3 per cent. of fibre (and often much more) on the weight of leaf; careful tests of the large blue aloe in India have given $2\frac{1}{3}$ per cent. only of fibre.

Furcraea gigantea (Mauritius hemp) gives a still less yield on the weight of leaf, the amount being, in Sylhet, from $1\frac{3}{4}$ to 2 per cent., but in this case the difference is largely counterbalanced by the larger weight of leaf obtained per acre. We will return to the question of yield later on, but in the meantime it would seem that one of the varieties of *Agave rigida*, preferably that known as *sisalana*, as we have described it, is the best for planting out commercially, that in its default the best will most probably be Mauritius hemp (*Furcraea gigantea*), while all other similar plants yet experimented with stand on a plane considerably below either of these, and their relative value in our districts cannot at present be judged.

CLASS OF SOIL REQUIRED.

Supposing a supply of plants is available, what is the type of land to be used for a sisal hemp plantation? On this point the most wild statements have been made. Some have even suggested that the poorer the land the better sisal hemp grows. While, however, this is not in any sense true, it may really be said that the sisal plant does not require a rich soil. In Yucatan the conditions are generally very much

poorer than are likely to occur in our Indian tea districts. A few inches of a limestone soil underlaid by limestone rock represents the usual condition of things.

It may be said from actual Sylhet experience, as well as that obtained in other countries :—

(1) That the first essential for sisal hemp culture is a well-drained soil. The tea plant is quite sensitive enough to standing water in the soil, but not nearly to the same extent as the sisal plant. A water-logged soil means dead sisal.

(2) That it is equally necessary that the land should be moderately light as that it should be drained. The tea plant flourishes fairly well on a stiff soil, provided it is well drained. With the sisal it is not so. The plants quickly become seedy and of no great value as fibre yielders. This is, at any rate, our Sylhet experience.

(3) That a too rich soil leads to very great luxuriance in the plants, but at the same time to a reduced percentage of fibre in the leaf, and that hence many of the rank virgin jungle lands of the Brahmaputra and Surma Valleys may be found not to give such economical results as less favoured portions of the tea districts. Exactly how rich a land may be without interfering with the fibre percentage has still to be tested, but substantially it may now be taken that on the richest lands there will be a greater percentage (given the same type of plant) of pulp, and a less percentage of fibre.

(4) That, on the other hand, if the land is too poor, the plants will always be poor, little luxuriant, and the fibre hence will be short. Seeing that fibre less than 3 ft. long has a comparatively small value on the market, the importance of avoiding lands which are too poor can easily be seen. We mention this because it has been often suggested to us to

plant sisal on badly washed old teela tea land. Some of this, as is well known, is little else but a bed of stones or sand, according to the situation. Such land will not do for a successful sisal plantation. Old tea land, we can quite believe will, in many instances, be found quite rich enough for agave fibre, but when all the soil has been cultivated away, or washed away, a successful planting of sisal is not at all likely.

Beyond these points it is usually considered that sisal hemp needs a soil containing a considerable amount of lime. In this constituent nearly all our otherwise suitable tea district soils are deficient, and though the plants grow luxuriantly enough at first, yet the probable necessity for the addition of lime at an early date in the history of an estate is a fact to be borne in mind.

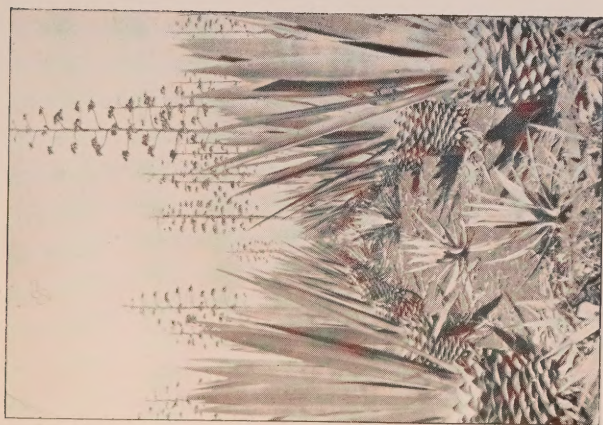
From all the information we have gathered from our own experience, and that of others, it may be said that the bulk of the rolling teela lands of Sylhet and Cachar are suited to sisal hemp culture, and the same may be said of the plateau soils of both the Surma and Brahmaputra Valleys where they are light enough in character. The low bheel lands, if composed of peat or clay are quite unsuitable, and in any low land the least chance of flooding or waterlogging should condemn the situation.

METHOD OF PLANTING.

BULBILS *versus* SUCKERS.

Having chosen the type of plant and land, the next question to consider is the method of planting, and here the first problem which arises is as to whether it is better to plant from "bulbils" or from "suckers"? We have described the two principal methods by which our plant is propagated, namely, by "bulbils" growing on the pole of the flowering,

PLATE III.



By courtesy

E. A. Sisal Growers' Asso.

Poled sisal plants, Kenya.

Note the suckers between the old plants.



By courtesy

Bureau of Agri., P.I.

Bulbils on sisal pole.

PLATE IV.



By courtesy

Dept. Agri., Nairobi.

Wholesale poling of sisal.
Showing sucker growth.

and hence dying, parent, and by suckers continuously thrown out from the root-stocks of the plant at almost all ages. Which of these forms is best for planting has been and is quite a moot point. In Yucatan suckers are exclusively used, and "bulbils" are rarely if even seen, for the pole is cut out as soon as it begins to grow. In the condition of things which we have at present in India when the number of plants available is limited, it is necessary to utilize the bulbils as well as the suckers, especially in forming a new sisal hemp garden. With regard to the general question, suckers, however, seem to represent the best means of reproduction. Sir Daniel Morris, perhaps the greatest authority on the subject, says: "I am of opinion that pole plants (i.e., bulbils) produced as an expiring effort of the parent plant are not always calculated to produce such robust plants as suckers. At least, they are not likely to be so when derived from plants whose leaves are periodically reduced when cut for fibre purposes. It would be well to investigate the matter experimentally. This might be done by planting suckers and pole plants side by side, and watching the results." Whatever the ultimate conclusion may be, at present, in the Indian tea districts, the use of "bulbils" or pole plants is inevitable owing to the number required. As each pole gives on the average about 1,200 to 4,000 young plants, it is the only way of getting a large number of young from the few existing established ones. It is probable that the use of "bulbils" will ultimately be all but entirely given up in favour of suckers.

MAKE USE OF NURSERIES.

Whether suckers or bulbils be used, it is wise if not essential to put the small plants out in nurseries. For this purpose a slightly sloping place of land with

a good friable soil should be chosen as a site, and, after being hoed and thoroughly cleared of weeds, made into beds of about 4 ft. in width. The tilth should be worked as fine as possible, and the nursery be as carefully prepared as if for tea. If bulbils be used, and are received small, they should be put in 6 in. apart—if obtained larger, 8 in. between the plants may be more suitable. The plants in any case are allowed to remain till from 8 in. to 1 ft. in height.

A few weedings are all the attention the nurseries require. No shading of any sort is generally needed, and the young plants should get all the sunshine possible. If the nursery is made in the rains, however, with very small plants, the violence of the rain may sometimes beat the soil inside the leaves of the bulbils. This is fatal, and under such circumstances it is wise, as Mr. Lawrie, of Daragaon, Sylhet, has suggested to us, to grow the plants under cover until they are big enough not to be affected by rain in this manner. But sunshine is necessary if the plants are to become strong. Any trees which shade the nursery should be in fact cut down.

Some authorities recommend the drying of the bulbils for a few days before planting them in the nursery, and say that this toughens and strengthens the plants, but so far as our own experiments go we have not found that it makes any perceptible difference whether so treated or not. In most cases some time must elapse between the gathering of the bulbils and the putting of them into the ground, but so long as they are kept dry no apprehension need be felt as regards decay or loss of germinating power.

Any time of the year is suitable for planting bulbils, but if they are put out in very dry weather they will be all the better for being watered a few times until they have sent their roots into the soil, after which they may be left alone.

If the nursery be made from suckers, the planting can be done similarly, the only difference being that, as suckers plants are usually larger than bulbils, they may be put in the nursery better perhaps at 8 in. or 9 in. apart than at 6 in., as suggested above.

PLANTING AND PLANTING OUT.

Land for planting should be cleared just as if it was intended to plant tea. If it has carried bamboos it is very necessary to see that the roots of these are killed.

In Yucatan the most approved distance for planting is 4 *varas* by $1\frac{1}{2}$ *varas*, a *vara* being equal to 33 in. This is therefore equal to 11 ft. by 4 ft. $1\frac{1}{2}$ in. Another system common in Central America is to put out 100 plants to the *mecate*, a *mecate* being equal to one-tenth of an acre. We have not seen any closer planting than this in America, which is of course equal to 1,000 plants to the acre. In deciding the rather difficult question of the distance apart to put out the plants in the Indian tea districts, it is important to remember that in any case the distance between the rows should be much greater than that between the plants, as this gives greater facility for carrying off the leaves; 5 ft. between the plants and 9 ft. or 10 ft. between the rows would seem a good distance apart for general use, as it would allow of working between the rows. One recently planted estate has put out the plants 4 ft. apart and 8 ft. between the rows. This we think will be found fully close when the estate reaches maturity. The terminal spikes on the leaves are very formidable weapons, giving nasty and apparently poisoned wounds, and they command respect from all who come in contact with them. Room must therefore be given to the leaf cutters to do their work without being continually

in dread of running against a spike every time they turn.

In actually planting out, a pit should be dug round every place where a plant is intended to be placed. It is not sufficient to make a hole with a dibble or pointed bamboo and put in the plant, but the soil round about must be carefully softened by a hoe, 4 in. to 6 in. deep, and the plant placed carefully in the softened soil.

It is *very* important not to plant too deep. In no case should the point of origin of the leaves be covered, as if this is done it is most likely that the new leaves will rot off as they are produced. In fact, it is even important to see that no soil gets into the inside of the leaves. This warning is of particular importance, as the plants are rather top-heavy, and are made to stand up so much more easily by being stuck well into the ground, that the coolies employed in the work are apt to plant too deep unless carefully watched. If this is done the result will be that in wet weather the plants will get sodden and rot.

WHEN TO PLANT.

As regards the best time for planting, February is considered the ideal month, but there really need be no fear of putting in plants at any time. If put out between November and the end of January the plants should be large and well-grown, in view of the long drought which may possibly follow. Again, one would hardly choose the height of the rains for planting out, especially in steep land, where the rain might loosen the soil before the young sisal hemp really gets hold of it, but with a few reservations like this, obvious to a tea planter, it may be said that sisal hemp may be put out at any time of the year most convenient to the manager of the property.

Plants, as has already been mentioned, should be

from 8 in. to 1 ft. high when lifted from the nursery. If a nursery is in a conveniently near position, two men and one woman will plant 500 plants of this size per day, or roughly half an acre. It has been questioned whether in taking the young plants from the nursery it is essential to take away all the root system which has developed there, or whether the roots may be cut. We think that there is little or no objection to cutting off the longer roots at this time, and certainly it saves a considerable amount of trouble in dealing with the plants. Such cutting, however, should be done with caution, and it must always be remembered that the greater the proportion of roots left on the plant, the quicker will the transplant take hold of the soil into which it is put, provided, of course, that it is properly planted and the roots are not badly bent or broken in carrying out the operation.

Terracing land for sisal hemp planting is not usually required, nor may be advisable, except perhaps on very steep land. Catch drains should, however, be placed on any very sloping land. Though the wash is not likely to be nearly so great as in the case of tea, owing to the little cultivation required, and to the growth of a certain amount of vegetation (which is encouraged), yet it is quite enough on the steep slopes to remove a good deal of the best of the surface soil in a few years. These catch drains should be laid out with a level, along the contour of teela land just as is the case with similar land planted with tea. It might be well at this point once again to insist on the absolute necessity of having well-drained land for sisal hemp culture. If it is not well drained naturally it must be made so. Standing water is absolutely fatal to the plant in the present case.

On the whole, therefore, it will be seen that the cost of putting out a fibre estate will be, for the first two years, not very much below that of a tea garden on

similar land. Clearing will cost the same ; staking and planting can be done for a little less, as the number of plants per acre is smaller. Not much will be saved on cultivation for this length of time, as it takes two years to kill the rank jungle growth, and thus the cost of hoeing during this period will be almost as great as with tea.

Summarizing therefore, it may be said that planting out in the Indian tea districts should be done with plants from 8 in. to 12 in. high, placed from 4 ft. to 6 ft. apart in rows which are themselves 8 ft. to 10 ft. from one another. The best time for planting is from February to June, but with care it can be done at almost any part of the year, and it is essential that the plants should be pitted (not dibbled in), and that they should not be buried in the ground above the base of the leaves. The land need not usually be terraced, but should be catch-drained if on a slope, and drained anyway if water is ever liable to stand on the land. The cost of the estate for the first two years will not be materially less than that of tea.

GROWTH OF A YOUNG GARDEN.

When successfully put out the young plants should grow about 1 ft. in height per annum. [The original shows the appearance of a plant put out in the cold weather of 1902-03, the photograph being taken in June, 1904.] Of course, in the most even of soil some plants will grow faster than others, but 1 ft. per annum at this stage will be about an average. During this time of growth the jungle must be kept down carefully. If it is allowed to grow up round the plants, and then suddenly hoed out, it is probable, and has happened in our own experience, that the shock of sudden exposure will be too much for the plant, the then existing leaves will die, and a check be given to its growth.

During this time the true sisal hemp plant has

several enemies, in Sylhet at any rate. Cattle form one of the worst, and if they are allowed to wander through a young sisal hemp garden they will inevitably put their feet on to and break the centre out of a number of plants. Not content with breaking the plant in this way, they occasionally pull out the hearts of the young plants with their teeth, if there is nothing more appetizing near at hand. Deer, in places where they abound, also eat out the young leaves. These dangers are however soon over, as only the young plants are affected. The big ones are well enough able to protect themselves against cows or any similar animal.

The most curious enemy is, however, what appears to be a cricket. It has not yet been identified, and is rarely seen, as it works entirely at night, but it cuts through the younger leaves and the core of the plants as with a knife. Thus the growth is retarded, often for three, four or even more months. Luckily, however, it confines its attention to plants under two years old.

While on this subject it may be well to mention two other difficulties of a similar sort already met with by sisal hemp planters in the Indian tea districts. The first of these is the sudden appearance of discoloured spots on some of the older leaves of even very young plants, which gradually turn brown, and the decay thus started may extend through a large part of the leaf. At first sight it seems an undoubted fungus attack, but we have failed hitherto to detect any fungus in the affected portions. It seems, therefore, likely to be the result of excessive evaporation through the leaves at very hot periods, when the soil contains a large quantity of moisture. It appears usually during the hot weather of April and May, and has in the past caused great anxiety to several who were experimenting with the fibre in Assam and Sylhet.

None of these difficulties seems to appear when Mauritius hemp (*Furcraea*) is grown. Cows will not touch this plant; the cricket seems to avoid it, and no perishing of the leaves similar to that just described has been noticed with it. Both it and sisal hemp are much bothered, however, by the growth of creepers which, if not interfered with, make the leaves and the cores and all parts of the plants a support for their growths. They distort the leaves, prevent the new leaves from opening out, and hitherto, in Sylhet, it has been necessary to have continually a gang of boys going round the estate cutting them off and untying them from round the plants.

There is still another danger which besets all these fibre plants. They are extremely sensitive to fire. In view of the frequent occurrence of fires round tea gardens, the danger to sisal hemp or Mauritius hemp plantations from this cause should never be forgotten.

WHEN AND AT WHAT AGE TO CUT.

Working a Mature Garden.

By the end of the second year the cultivation of the garden will have become reduced to keeping the ground clean immediately round the plants, and to removing any rank jungle which tends to form in between. From all evidence at hand at present, it seems advisable not to discourage the growth of a fine grass between the rows, but of course such rank jungle as *sunni* grass must relentlessly be removed. Three hoeings or weedings per annum appear to be amply sufficient to keep the jungle down in ordinary cases, with more frequent removal of creepers as necessary.

In the third year from putting out the plants should have attained a height of over 4 ft., and are big enough to permit of cutting a few leaves. As before explained, the leaves open from a central core and gradually are

pushed out from the centre by the growth until they finally reach a position at right angles to the trunk of the plant characteristic of sisal. In practice they are considered ready to cut when they have reached a point forming about half a right angle with the trunk, but none should be cut at a less angle than that. In the original Plate I, fig. 1, showed a sisal hemp plant just after cutting, and Plate I, fig. 2, a *Furcraea* plant similarly cut, but will not make good blocks for use here.

Cutting of the leaves may be made at all times of the year, but in the Indian tea districts there are strong reasons for limiting this operation practically to the months from October to June. The principal reason is that in these times only is the atmosphere sufficiently far from saturation for the fibre to dry in the open air, and any necessity for artificial drying at once increases enormously the cost of producing the material. A second reason is that the weight obtained per leaf is greater during the dry weather, and as the cost of carrying in the leaves forms so great an item in the working expenses, any reduction which can be made in the amount it is necessary to carry is certainly to be welcomed. Worked as a by-product in a tea garden, this lack of need for manufacture from June to October will be appreciated, as the labour will then largely be free to help in tea culture and plucking during the busy manufacturing season.

The method of cutting the leaves is very simple, and a good man will cut 3,000 a day. An ordinary tea-pruning knife with a blade 8 in. long will be found an excellent weapon for the work. The leaves should be cut as close to the stem as is possible, as it seems better for the health of the plant that no long butt ends should be left; it looks better, and longer fibre is obtained and more of it. If thorns occur on the side of the leaf, these should be removed at the same time as the leaves are cut, and with the same knife—a

corresponding reduction being made in the cutter's task.

From plants 3 years old very little fibre will be obtained. The leaves to be cut will then be only about 3 ft. long and correspondingly narrow. Anything from 1 cwt. to 2 cwt. per acre of fibre is quite as much as can be expected. During the following year, however, a return of 5 cwt. per acre may be expected, which will be more than doubled in the fifth year from planting, when the plant may be said to have attained maturity. From this time until it poles a mature plant should yield from twenty-four to thirty leaves per annum. These, however, will not be all cut at one time, but should be spread over at least three operations, and better over four. Beginning in October, three cuttings might be taken by the end of April in the following year, and one after this time. Such is our Sylhet experience. The fewer leaves cut at one time the less shock is given to the plant, and the better is the chance of getting the leaves thoroughly ripe, and the fibre at its maximum weight and strength.

YIELDS.

The usual weight of a good mature sisal hemp leaf (*Agave rigida* variety *sisalana*) is from $1\frac{1}{2}$ to 2 lb. on the Dauracherra estate, or say 1,500 lb. per 1,000 leaves. This yields 50 to 60 lb. of marketable fibre though the amount varies considerably on different parts of the estate and with different plants. The percentage on the weight of leaf thus comes out at 3.3 to 4.0. In Yucatan 50 lb. per 1,000 leaves is considered a fair average outturn, though occasional patches of sisal may give as high a yield as 100 lb. of fibre per 1,000 leaves, or a weight percentage of $6\frac{1}{2}$.

Furcraea plants (Mauritius hemp), as cultivated at Dauracherra, give about the same number of leaves

as sisal hemp, but these are each much bigger than the latter. They often reach 3 lb. in weight per leaf, and 1,000 mature leaves will weigh about 2,500 lb. The percentage obtained from this varies from $1\frac{3}{4}$ to 2, or a yield from 1,000 leaves of 45 to 50 lb.

At this rate, which is about reached in our Sylhet experience, and with 1,000 plants per acre, the out-turn of a mature garden full of plants would reach from 1,250 to 1,500 lb. of clean sisal hemp fibre per acre, and rather less than this amount of *Furcraea* (Mauritius hemp). This of course means about 11 cwt. to $13\frac{1}{2}$ cwt. per acre, an amount which compares well with the average of 700 lb. per acre said to be given by the Yucatan plantations.

RENEWAL OF GARDEN.

After an agave or furcraea plant has reached maturity, it "poles," that is to say, it sends up from the centre a high flower stalk, flowers, and dies. It is therefore obvious that one of the most important matters in a sisal hemp garden is to know how long will elapse before this takes place and the plants have to be renewed, if the garden is to continue as a permanently yielding one.

At present little reliable information is at hand as to the period which elapses before poling under Indian conditions. In Yucatan, where there has been plenty of time to study the life of the plant under varying conditions, the average term of life before poling takes place for the true sisal hemp is found to be fifteen years, though on some estates it extends to twenty years. A great deal, however, seems to depend on the individuality of the plant and even more on its environment. Of two plants put out from bulbils or suckers originally obtained from the same source, and apparently similar in every respect, one may flower a

year or even two years earlier than the other. This effect of individuality it seems hopeless to control, unless ultimately suckers or bulbils be exclusively used which have been produced from long-lived plants. Such a process of selection is, in India, for the future, but will probably be a very important matter in a few years. It seems certain that the idea that, just as the bamboo and cuttings from the same root, flower at the same time, so all the suckers from one original agave plant flower contemporaneously is wrong. There is no evidence that this is the case. We have been informed, in fact, of suckers poling in their first year in Sylhet while the parent was still healthy and vigorous. On the basis of this principle, however, the advisability of sucker planting has been questioned, but our experience leads us to believe that there is nothing in it, and in this we are in agreement with the opinion in Yucatan. Pole plants (bulbils) also occasionally themselves pole while actually attached to the parent.

The effect of environment seems to be greater than that of individuality on the time of poling. Thus, for instance, by pushing the growth with manure, and growing the plants under the most forcing conditions, poling was produced in four years in an experiment made some time ago at Allynugger, Sylhet. We anticipate, in fact, that the conditions occurring in Sylhet will, generally speaking, reduce the life of the plant considerably below that found in Yucatan. Experience so far has given ten to twelve years as the normal period of life with us. Plants put out at Dauracherra in 1892-93 have now been poling since 1902, though there are many plants there put out at the same time which have not yet flowered. Similar data are available elsewhere in the tea districts.

It is further said in America that regular and

judicious cutting of the leaves tends to lengthen the life of the plant, but that over-cutting shortens it, and makes it form poles at a much earlier date. We can well believe the latter, but our experience in Sylhet is too short to entitle us to give an opinion on this point, under our conditions.

It has been suggested that under our forcing conditions of growth there will probably be a tendency for the life of the plants to get shorter in succeeding generations. Whether this will be the case or not no one can say at present. The agaves have not been carefully watched for a long enough period to decide this point one way or the other. If there is such a tendency it will make sisal hemp planting more difficult, if not impossible; but it is a matter which only the future can decide.

The practical bearing of the whole question, however, turns on the means to be adopted to renew the plants which die in this way. In any case, before they have reached the poling stage they will have produced a number of suckers from which the garden must be kept up. These suckers are produced at any period of the plant's life, but in the greatest number during its second, third and fourth year, after which their number grows smaller. They appear very irregularly, some plants producing a great many, some fewer, and some none at all. Where numerous, these should be cut away when small and put into nurseries, and probably this is the best method in every case. When only one or even two appear on a plant, it is often preferred to leave them in place attached to the parent until big enough to plant out. Such preference is however doubtful policy, and Sir D. Morris, of the West Indies, is of opinion that if they are so left, either the parent plant will produce fewer and smaller leaves, or it will pole at an earlier date.¹

¹ *Kew Bulletin*, November, 1893.

At the first sign of poling, however, large plants will be available, say 2 ft. high and 2 years old, to replace that which is coming into flower. If the pole of the flowering plant be cut out when first noticed, the plant will give its full quota of leaves for that year, as they will then ripen normally, though if the pole is allowed to grow the leaf will be practically worthless. Hence the flower stalk should always be cut out on first appearance, unless bulbils are more valuable than fibre, when the latter will be sacrificed to the former.

By the time, however, the old plant is dead, the new sucker planted beside it will be 3 years old, and will be beginning to yield, while the following year it will give half a crop, so that comparatively little interruption will take place in the harvesting of the leaves.

COMMUNICATIONS.

After the fibre is cut, bundled, and carried to the nearest road, it has to be taken to the factory. Owing to its enormous weight (at least twenty-five to thirty times the weight of the fibre to be produced), it is necessary to have good roads and plenty of them if a sisal hemp estate is to be successfully worked. It will be at once seen that this is infinitely more important than even on a tea garden, and the fact that communication to the factory *must* be easy and cheap, rules a large part of the arrangements of the estate.

The factory, for instance, should be as near the working centre of the area as possible, consistent with a good water supply, and with getting the fibre away after manufacture, and all roads should lead by as level a route as possible to this point. On moderately level land the planning of a system of roads is a simple matter, but on land with a heavy roll it will

demand more thought to ensure good communications at the lowest possible cost, and to obviate the necessity of having to carry leaves over hill tops. In any case the roads must be good, and well kept at all times.

On a small estate pack bullocks, or else a bullock cart, are generally used to bring in the leaf. But with a larger estate a light railway in some form or other becomes almost essential, whether propelled by hand, by bullock, or by power. In estimating the cost of an estate this item should never be left out of consideration.

FACTORIES.

The factory, as we have said, should be as near the centre of the garden as possible, in order to reduce the cost of carriage of the leaf. In deciding on a site, other considerations which should enter are as follows :—

(1) The accessibility of a copious water supply. As we shall afterwards show, the fibre will have to be rinsed with water whatever machine be used. Whether this be done in the machine, or the rinsing be afterwards done, water, and much of it, is essential. A good many thousand gallons a day will inevitably be required during the working season for an estate of any size.

(2) Space for a sufficient amount of drying ground. For a thousand-acre estate, at least one hundred yards square must be provided, and double this allowance will be found useful. We will return, however to this point.

(3) Means of disposing of the refuse. In an ideal factory this will immediately be carried back to the garden. This cannot always be done, and so a certain amount of space for tipping it will be necessary.

(4) Ease of despatch of the fibre, whether by river or by train or by a good road.

It will not be necessary to suggest anything in the construction of a factory to tea planting readers, and we shall pass over this matter. Room will be required for—

- (1) Engine and boiler.
- (2) Fibre extracting machines.
- (3) Drying fibre out of doors.
- (4) Storing of half-dried fibre under cover
when necessary.
- (5) Baling of the fibre.

FIBRE-EXTRACTING MACHINES.

The cleaning of the sisal hemp or Mauritius hemp fibre by hand is a very simple operation. Given a block of wood, another piece of wood to use as a mallet, and a supply of water, and fibre can be produced by anyone. But the commercial use of the fibre was impossible until the extraction went a stage beyond this point. The original machine devised in Mexico, termed the "Raspador" and worked by hand, has been the model from which all the later, larger and more automatic, ones have developed, and the improvements have almost entirely consisted in provision for running by power, for the automatic or semi-automatic handling of the fibre, for washing the fibre during the process, and so on. The principle of all of them remains the same as in the original Raspador.

This machine, of which a sketch is shown on p. 31, consists simply of a rotating wheel with beaters, which descend on the leaf held rigidly in a slit, and kept in contact with the wheel for a quarter of its circumference by a curved board. The action is thus a combination of beating, scraping, and pulling, the result being that the leaf is broken up and the refuse carried away at the same time. The wheel is usually made 54 in. in

diameter with about 15 beaters, and as now made it requires a 2-horse power engine to drive it at a steady rate of 200 revolutions per minute, at which the best results are obtained. The great difficulty in working such a machine is the regulation of the slit through which the leaf is passed. If it is held too fast the fibre is torn and the leaf broken by the rotating wheel; if held too slackly the cleaning is by no means perfect.

The application of this principle has resulted in the

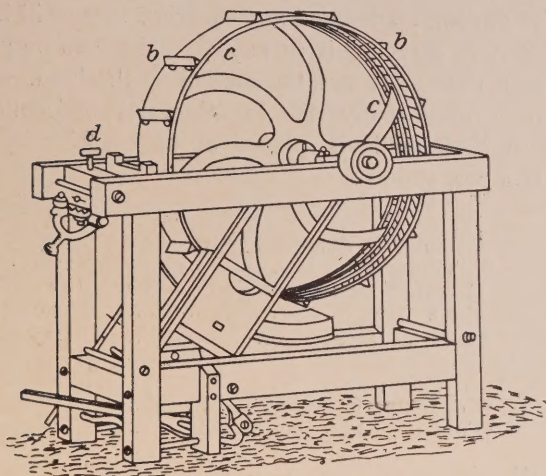


FIG. 2.—The "Raspador" machine (after Dodge).

existence of some dozens of machines of all sizes. We do not intend here to even mention more than a very few of them. But they may be divided into three classes, all being now, of course, run by power :—

(1) The machines in which each leaf is held in the hand of the worker.

(2) The semi-automatic machines, often washing the fibre during its passage through, where several leaves are dealt with at once.

(3) The completely automatic machines.

DISPOSAL OF WASTE.¹

The disposal of the waste from a sisal hemp factory is quite an important problem. The pulp is an acid mass, quickly becoming very objectionable in character,² which must be at once removed. In the large machines it will be necessary to provide trucks for it to fall into, running on a line which will carry it straightway from the factory neighbourhood. Its natural use will be as manure, and if a light railway in the garden be deemed an essential, there will be no difficulty in carrying it to any plot, there to be pitted till such time as it can be applied to the land. This waste is abnormally rich in mineral constituents, as the attached analysis, placed at our service by Mr. D. Hooper, shows :—

Water	81.33
Chlorophyll, &c.	.67
*Albuminoids	2.26
Carbohydrates, Digestible Fibre, &c.	10.81
Fibre	.69
†Ash	4.24
	100.00
*Containing Nitrogen	.36
†Containing Phosphoric Acid	.20

We should strongly advise the use of this material as manure if it can possibly be arranged, as it contains practically all the valuable constituents the plant has removed from the soil, and by this means it is possible to return them to the land. Other uses for this waste have been suggested. It has, for instance, a certain insecticidal action. The important matter, however,

¹ The use of the waste fibre for paper making, the liquid for industrial alcohol or motor spirit, and the solids for manure, is discussed elsewhere.—H. H. S.

² The refuse from Mauritius hemp is even more objectionable than that from sisal hemp. In either case the men dealing with it are apt to get sores on the hands.

is to get it removed from the factory neighbourhood at once, and usefully employed in some manner if this is possible.

DRYING AND BALING THE FIBRE.

After the fibre has been extracted it will require to be washed and dried. In Yucatan it is not washed, but passes straight from the extracting machine to the drying yard. We strongly recommend, however, that it should be carefully rinsed in water, as, whatever may be the case in America, it seems to turn a dark blackish colour in our districts if dried without washing. Even where water is used in the extracting machine, it will be found of very much advantage to rinse it after leaving the machine.

As far as drying is concerned, this is always done, when weather conditions allow, in the open. A space of 100 yards square at least is required for drying the fibre, we find, from 1,000 acres of sisal hemp. Rows of post, rail or bamboo fences about 3 ft. high should be erected at intervals of 4 ft., or just far enough apart to allow of the carriers getting easily up and down with their loads. The fibre is simply put thinly over the fence and left till it is quite dry. The length of time required for this varies, of course, with the dryness of the atmosphere, but the dryer it is when baled the less likely it is that any deterioration in quality will take place afterwards. A store-room or shed must be provided in which the half- or partially-dried fibre can be placed at night for safety and to avoid it getting wet again by rain or dew. It has been said that a better-coloured fibre is obtained when it is dried in the shade rather than in the sun, and that in the latter case there seems in India a tendency for the colour to become brownish after the fibre has been some time dry. This is not, however, our experience.

In fact, we might say that with us in Sylhet the more sunshine it gets the better.

When quite dry the fibre is taken to the press and baled for shipment. All estates in Yucatan are provided with their own baling premises. On the smaller estates the baling machines are screw presses, but in more advanced and larger properties hydraulic presses are universally employed. This is the only operation to be performed after the fibre is dried in order to prepare the material for the market. The bales universally in use in this fibre market weigh 400 lb. each, or slightly less than six to the ton. At present it is quite possible that it would be more advisable to send down the fibre to Calcutta from the tea districts in smaller "*kutchas*" bales, and get it baled for market in one of the large jute-baling establishments there. This is, however, a practical matter which only greater experience than has been obtainable hitherto can decide. It is important, however, that as far as possible the fibre should be baled, laid out straight and in its full length—and the nearer such full length baling can be approached in practice the more valuable will be the fibre when opened for sale. It should also be noted that too hard baling is not in favour among buyers.

PROSPECTS OF A SISAL FIBRE INDUSTRY.

We have now gone somewhat lengthily into the technique of sisal hemp fibre growing and manufacture, but the most important question, from a practical point of view, remains. Does the industry offer sufficient probability of profit to encourage the investment of capital in it in the Indian tea districts?

In order to answer this, so far as it is possible to do with the limited experience hitherto acquired by actual planting on the spot, it will be necessary to consider the

various factors which tend to the success or otherwise of a new industry. These may be stated as follows :—

(1) What is the capital per acre needed to found a fibre estate in the tea districts ; what is the running cost per ton of fibre produced ; and what price is it likely that the material will fetch ?

(2) Do the tea districts of India present any special advantages or disadvantages over other parts of India or the world which would enable them to compete otherwise with other places ?

(3) Is the quality of the material produced as high as that made elsewhere ?

(4) Is the sisal hemp or Mauritius hemp fibre an easily marketable commodity ?

(5) Are the market conditions likely to remain stable, or is over-production likely to occur at an early date ?

The capital per acre required to bring a sisal hemp fibre estate into bearing is comparatively great, though not quite so great as for a tea estate. There is the same land to clear, there are the same nurseries to attend to, there is the same staking and planting (though for less plants) to undertake, there is the same cultivation during the first two years. There is also a factory to build which, while not costing quite so much as a tea factory for a similar-sized estate, is still an expensive one.

The cost of the land and of clearing may be taken to be the same as for tea. The item of cultivation for the first two years may be similarly taken as not very different from that required on a tea garden. After that time the labour force necessary is, or ought to be, rapidly reduced to not more than one coolie per four or even five acres, as judged by our Sylhet experience.

The cost of true sisal hemp plants is at present a large item, simply because the number of plants in India has been hitherto very limited, and export of

plants from Yucatan or the Bahamas is under a strict embargo. The supply from Indian sources is likely to remain short for at least five years from now, and the price of 5 rupees or more per 100, at which they are at present valued, is not likely to fall materially in the meantime. The cost of plants at this rate would be at least 50 rupees per acre, a very large addition to the capital cost of a garden.

There are two means of getting over this difficulty. Plants might, in the first place, be imported direct from Florida, whence they can be obtained fairly easily. But seeing that so many attempts to import plants have ended in failure, it would be well to point out that bulbils travel very well only when in a dry condition and packed dry in moss or some similar material. If any attempt is made to import plants in a moist condition, they will merely arrive as a stinking mass of rotteness, but brought in as just described they will most probably, in large proportion, reach India all right, and can be planted out in nurseries at once. It has been suspected sometimes that such imported plants have been heated before packing, and thus do not come to anything; this shows the necessity of importing, if importation is undertaken at all, from respectable firms only.

In the second place, if true sisal hemp plants are short in India other types of plant might be used. Already a good deal of *Furcraea* (Mauritius hemp) has been put out as a makeshift for sisal hemp. The plants of this species are always available at less than half the price of true sisal, and there is always a market for its fibre. We would not like to recommend, as regards this fibre plant, that it should *not* be put out, but at the same time it produces a less valuable fibre (see quotations, pp. 48-50), and no more of it per acre, while the handling charges in the garden and factory are greater. It forms, however, the best

substitute for sisal hemp we are acquainted with, and will probably pay well as an adjunct to a tea garden.

Other and common agaves have been suggested as substitutes for sisal. Some have even been put out. If it was not that the whole garden has to be renewed, on account of the plants poling, within fifteen years, we should think there was little or no excuse for such planting. It would be as bad a matter as if a tea garden were put out now from China *ját* plants. The fibre of any that have been tested in the tea districts is at least £5 per ton less in value than true sisal hemp, and less is obtained per acre, while the cost of working is the same. It will also tend to create a bad name on the market for the mark under which it is sold. But, on the other hand, as the plants pole they may be replaced by better plants (true sisal hemp), and it will be possible in, say, twelve years to have completely replanted the garden with true sisal hemp plants which, long before that time, will almost certainly be quite cheap to buy. Such a scheme will however involve buying plants twice over. Instead of being able to use the suckers of the already existing plants for replacing those that die, new ones will have to be bought, and all this means additional expense later on. On the other hand, to permanently have an estate planted with any other species than true sisal hemp or true Mauritius hemp, is, so far as our knowledge at present goes of a number of kinds tried in the tea districts, to condemn the garden to always produce a smaller crop of inferior fibre. We cannot, therefore, recommend any way of getting over the present scarcity of true sisal plants except by direct import of plants from Florida, or by planting Mauritius hemp. Other species must be individually tested as an experiment under the conditions of the garden before one can judge whether any of them are worth planting.

Apart, therefore, from the cost of sisal hemp plants,

which at present is very high, for temporary reasons, as we have explained, the actual cost of planting out a garden and bringing it to maturity will be a little under that of bringing a tea estate of the same size to the same point under similar conditions. The cost of the factory buildings and machinery will be considerably less if the area is large enough, say 1,000 acres. To fully equip a factory for this sized estate will, judged again by Sylhet experience, cost about £3,000 sterling; and, including this, the whole cost of such an estate will run from £15 to £25 per acre and should *never* exceed the latter figure.

When we turn to consider the running cost of an estate of this size, a great difference from a tea garden is at once evident. The cultivation needed is less; the cutting, carting, and manufacturing the leaf from an acreage does not need nearly so many coolies as the same area of tea would require, and if the place is run in connection with or near a tea garden, a considerable part of the labour force of the sisal hemp estate would be free to work on it during part, at any rate, of the busy season in July, August and September. One cooly to four acres is all that can be required, and this not necessarily throughout the year. The cost per acre for all charges, including putting the fibre in Calcutta, should not in Sylhet be much more than £7. Reckoning two-thirds of a ton of cleaned fibre per acre as a fair outturn, this should be put in Calcutta from Sylhet for between £10 and £11 per ton. To this would have to be added the freight to London to make a comparison of this amount with the prices quoted later as ruling there.¹

To compare with these figures, obtained from the working of Dauracherra in Sylhet, it is interesting to

¹ It is hardly necessary again to remind readers to remember that these prices and the advice given refer to conditions prevailing twenty-five years ago.—H. H. S.

give the cost as worked out per ton on the basis of an outturn of 1,000 tons per annum at the Agave Fibre Co.'s place at Powai, Bombay, as published by that company. Their returns work out as follows:—

			£	s.	d.
1. Cutting and Bundling of the Leaves	...	...	0	16	0
2. Transport to Factory of Leaves	...	...	0	12	0
3. Labour in Extracting Fibre	...	...	2	0	0
4. Engineer, Firemen, Fuel, &c.	...	...	2	8	0
5. Pressing, Baling, Carting and Shipping	...	...	1	8	0
6. Insurance and Freight to Europe	...	...	1	8	0
7. Commission, Brokerage and Sale	...	...	2	0	0
8. Maintenance of Factory and Plantations	...	...	0	12	0
9. Management and General Expenses	...	...	2	8	0
10. Contingencies	...	...	0	8	0
			£14	0	0

Add to our figure for Sylhet the cost as here given for insurance, freight, brokerage, and sale charges, the price in London from the tea districts would be £13 8s. to £14 8s., an amount which very closely agrees with that given here for the Bombay plantation.

Now the local cost in the Bahamas is given in a recent official publication¹ as not exceeding £10 a ton, to which has to be added a smaller freight than ours, as all, or practically all, is sent to New York.

In Yucatan the cost is greater, though very definite figures are not easy to get. But apparently it is near £14 at the port of shipment, and there is also an export duty on the fibre.

Judging by our experience of Indian costs in Sylhet and near Bombay, it would therefore appear that so far as we can see at present it will run nearly level with that in the Bahamas and a little under that in Yucatan.

To ascertain what profit there may be, it will be necessary to anticipate somewhat the fifth question

¹ Report of the Colonial Secretary of the Bahamas, 1900.

we have set ourselves to answer, namely, the stability or otherwise of the market. To discuss this we must again refer to the history of the industry in recent years. Previous to 1889 sisal hemp was in small demand, almost exclusively in the United States, and was more or less entirely produced in Yucatan. Its price varied from £20 to £35 per ton (put into British gold currency). In 1889, owing to the operations of the National Cordage Trust in America, the price went up by leaps and bounds, and finally, in London, touched £56 10s. per ton.¹ This high price encouraged the trade, and much land was put out in Yucatan and in the Bahamas during the year or two that followed, as well as elsewhere. In 1891, 286,700 bales were received in the United States (10,006 being re-shipped to England), but the total import into the United Kingdom was only 20,296 bales, showing what a small share England had at that time, as now, in the consumption of the product.

From this date the price rapidly dropped, touching as low as £15 per ton in 1894, and £12 10s. in 1895. From this time to the present year the fluctuations in price are shown in the Appendix, p. 48. In 1896 a slight rise occurred, but till early in 1898 the average price never went above £20 per ton. Then came the Spanish-American war, which cut off temporarily the supply of Manila hemp, and the price of sisal hemp (the most suitable fibre for replacing it) went up, once reaching £42 per ton in June of 1898. Since that time the price has never descended to its old level, and has remained, for good sisal hemp, at £30 or above. 1902 was one of the best years for price that sisal hemp ever had.

This general increase in value has been due chiefly

¹ This is hardly perhaps a fair statement. This price was only paid for a small lot for a special purpose. £55 was the real market price at the time.

to two causes: (1) A great increase in demand; and (2) a great replacement of Manila hemp by sisal hemp. To take the second point first. Of old, sisal hemp was used as an adulterant of Manila hemp; when supplies of the latter became short the former entirely replaced it, and has now been found to be better for many of the same purposes, notably for twine for self-binding harvesters, which are now universally used in the Western States of America, and increasingly in every corn-growing country in the world. For this purpose it is less affected by dampness than the Manila hemp, and also much less than many other of the agave fibres.

In addition, there has been a large increase in demand which the Manila hemp has not been able to fill, nor is likely to fill.¹ This increase in demand is shown by the exports from Yucatan and from the Bahamas for several years. For Yucatan we have no figures later than 1901, but previous to that the following amounts were exported year by year (we give the figures in bales; these may be taken as, roughly, six to the ton):—

	To United States	To United Kingdom	To other countries	Total
	Bales	Bales	Bales	Bales
1896	371,874	13,542	11,747	397,163
1897	400,030	7,310	12,643	419,983
1898	411,138	3,678	4,156	418,972
1899	428,084	9,248	8,646	445,978
1900	488,503	2,349	8,782	499,634

For 1901 we have not got the figures thus analysed, but the total export from Mexico was 83,658 tons in

¹ The Philippines are practically the only source of Manila hemp in the world, but it forms 75 per cent. of the total value of the exports from these islands. The amount exported in 1901 was 913,349 bales; in 1902, 846,520 bales.

the rough and 3,764 tons manufactured,¹ or another increase on the amount for 1900. It is thought, however, by competent observers that Yucatan has about reached its limit of production for the present, owing to the lack of labour available to work more land.

The Bahamas only entered seriously into the sisal hemp market in the early nineties, and with some temporary arrests the amount of fibre exported has increased year by year.² The total amount leaving the colony in recent years was as follows :—

	Weight	Value
	lb.	£
1898	1,251,730	14,710
1899	1,358,682	16,492
1900 ³	1,276,037	16,246
1902 ²	2,345,311	37,574

The principal two sources at present, therefore, were yielding in 1901 and 1902 nearly 88,500 tons of sisal hemp fibre, a very large increase on what the market was consuming four years before. Exact data are not before us since that time, but the increase in the amount on the market has been continuous, while the price has remained very constant since the beginning of 1903, though declining a little on the prices of 1902. The London fibre brokers, however, are of opinion that the market can now absorb a very large amount more than it has ever hitherto received, and that the demand will continually increase for a good many years to come. They anticipate that the price of £30 for good quality sisal hemp will be maintained for some years at least.

¹ This makes a total of 87,422 roughly or about 524,532 bales.

² Report of Bahamas Islands for 1902. Blue book issued March 1904.

This being the case the profit is a very handsome one. Taking £14 as the cost of placing the fibre on the London market, and £30 as the price for well prepared fibre, the profit per ton would be £16. As this is obtainable from $1\frac{1}{2}$ acres in full bearing it gives a profit of £10 13s. 4d. per acre. But it must not be forgotten that the price of the fibre has been subject to violent fluctuations in the past, and is likely to be subject to them in the future. Perhaps there is less liability to fluctuation from casual causes, because the market is larger and wider every year, but were the material really over-produced, as it was in 1893, 1894 and 1895 the price would quickly drop very low. Anyone entering the fibre industry must be prepared to face a fall in value to £20 per ton, and even a drop to £15 is not excluded, though it is not likely in the immediate future.

But is over-production at all likely? This we can consider in connection with the question as to whether the tea districts of India possess special advantages over others both in and out of India, which would enable them to compete if over-production did occur.

At present, the Yucatan out-turn is, as we have already said, held by competent men to have reached nearly its maximum. The Bahamas, however, are still forging ahead, and putting out sisal hemp gardens or extending present ones. The Governor in the most recent report¹ on the Islands says: "The cultivation is extending, and bids fair to be a permanent and promising one for these Islands." Other West Indian Islands are also entering or have entered on the same industry. The Turks and Caicos Islands, Jamaica, Trinidad have all developed an industry or experimented with the plant. East Africa, West Africa, South Africa, and Algeria are all experimental fields for agave culture, as well as

¹ Dated March, 1904.

the Philippines, whence a similar material, "Manila aloe fibre" has long been exported. In Florida the industry has developed further than in some of these quarters, and it is being taken up more or less tentatively in several of the Southern States.

So far as India itself is concerned, we have the Agave Fibre Company, Bombay, and one or two concerns in Madras, besides several places (mostly growing inferior fibre) in other parts of India. The railway bunds in many parts of the country are lined with the large blue aloe (*Agave lurida* (?)) which is, in very few places, being used for fibre.

It is probable, therefore, that in five years time the sources of the world supply will be considerably increased, but the London brokers seem to think that in spite of this there is little fear of over-production for many years to come, and that the market could take a prospective supply largely in excess of what it is likely to get.

The tea districts occupy an advantageous position in that the plants appear to grow faster than in many of the places where sisal hemp has been planted; that water for dealing with the crop is usually abundant; that communications are generally good; that working in connection with a tea garden gives the chance of adequate and trained supervision, and probably an engineer on the spot: that land is cheap: that the adjoining tea garden gives an outlet for surplus labour during the off season in the sisal hemp estate. It is questionable whether many other districts in the world possess a greater sum total of advantages, and coupled with the fact of the cheap and yet good agricultural labour, we feel inclined to think that if the industry is likely to succeed anywhere it will in some parts of the Indian Tea districts. There are places even there, however, in which its success is more than problematical. If the labour has to be

imported at an enormous cost (as say on the Sadya Road, Upper Assam), this circumstance alters the whole aspect of affairs: the same may be said where a very long road journey is required to get the material to an outlet, and so on.

It is impossible for the moment to say whether or no the tea districts, or such parts of them as we have suggested for planting, are or are not better than many other parts of India itself for the growth of sisal hemp. This would be governed by questions of soil, of climate, of labour conditions which can only be sufficiently cleared up by experiment on the growth in those districts. It is not enough in this connection to show that agaves will grow in a particular spot, though this has been imagined to be the case by many who have touched the subject. Plants will often grow and grow luxuriantly where they will not grow *economically*, and only an experiment, such as is now being made in several parts of the tea districts, can show whether an industry can be based on the growth of the plant.

Another matter must be mentioned. The deterioration of quality in the fibre produced in a wet district like that of Sylhet or Assam has often been prophesied, and really there would seem, at first, some reason for supposing that such deterioration would be a likely result. Experience, however, has not confirmed the position. The Agave Fibre Co.'s estate at Powai, Bombay, is in a similar wet country, and its fibre has always stood very well on the London market in comparison with that from America: The same may be said of the few consignments already sent from Sylhet, and, given good methods of manufacture, a soil of not too forcing a character, and careful marketing, there is no reason, from actual results, at present to lead us to suspect that the quality of material prepared from the true sisal hemp plant will

suffer any deterioration whatsoever when produced in our tea districts.

The few additional notes which remain to be made concern the best position for the industry to take in the tea districts themselves, and the method of marketing the crop. With regard to the first point we are emphatically of opinion that sisal hemp should generally rather aim at being a by-product to tea than exist on an independent footing. Not that the sisal hemp garden must only get attention when the tea does not require it, for such a system will quickly ruin the garden and bring the product into disrepute. But, though on a separate footing, with its own labour force, yet there are times in the year when the work being carried out on a sisal hemp plantation will not need nearly its full complement of labour, and these times are precisely those when the tea garden is usually in need of all the labour it can get. The two materials can thus work together to their mutual advantage. As regards the size of the sisal hemp property, the working is bound to be expensive and not economical till the area becomes sufficiently great to allow of the purchase and use of automatic or semi-automatic machines, of rails in the garden for bringing in leaf and taking away refuse, and the various other refinements only possible on a large acreage. While we know that under the present dearth of plants the area must be built up as plants *can* be obtained, the ultimate aim in ordinary cases should not be less than five hundred acres, turning out when in full bearing say 300 to 350 tons of fibre per annum.

Furthermore a small acreage means a difficult market.¹ Indian sisal hemp is a new product which is only likely to receive proper market treatment and

¹ See "Sisal Economics," by Major Notcutt.

sell at proper market rates when the amount available is enough to ensure a fairly considerable supply. During the preliminary stages when places are small, we would strongly suggest for several estates to market their product in common, in order to ensure proper attention being devoted to the goods when they come to sale by those who would hardly look at a product if there was only an irregular consignment of a few bales.

Finally, then, we think that a careful and impartial view of the whole history and present position of the trade leads us to the conclusion that in many parts of the Indian tea districts sisal hemp fibre can be produced in competition with nearly all, if not with all, the countries and districts in which it has been tried, that the quality will remain as good as that obtained from America, and that it will be a number of years now at least before there is likely to be any such slackening in the annual increase of the demand as to lead to serious over-production and so bring down the price below a remunerative figure. Under these conditions we think that in sisal hemp fibre a by-product to tea culture has been found, the culture of which will be of advantage to the existing tea industry, and lead to a great expansion of effort in the tea districts, as well as to a further development of those regions of India which need it most.

SISAL.

APPENDIX I.—PRICES OBTAINED PER TON ON THE LONDON MARKET, 1895-1904.

	1895	1896	1897	1898	1899	1900	1901	1902	1903
January	£ 15 to 15½	£ 16½	£ 16½	£ 19	£ 27	£ 43	£ 30	£ 40	£ 38
February	15 ,, 15½	16½	16	20	28	28¹	29½ to 30	44½	36
March	14	17½	14 to 15	21 to 22	32	42 to 43	31	41	36
April	14	17½	15	22	34	42 ,, 43	30	46	34
May	13½	17½ to 21	15	—	32	40 ,, 41	31	50	39
June	13½	16½	15	40 to 42²	31	38 ,, 39	—	42	39
July	12½	16	15	36 ,, 37	31	35 ,, 36	30	42	37
August	15½	14½	16	30 ,, 32	37 to 38	32 ,, 36	28	44 to 45	35
September	15½	15½	16½	30 ,, 32	37 ,, 38	32 ,, 36	35	43	36
October	16 to 17	15¾	18	31 ,, 34	41 ,, 42	30	38½	43	37
November... ..	16½	16½	19	30 ,, 34	44	30	41 to 42	40	38
December... ..	15	16½	19	26 ,, 30	39 to 40	30	42	40	36

The prices in 1904 have been as follows: January, £35; February, £34; March, £34; April, £34; May, £35; June, £34; July, £34.

¹ See remarks concerning the drop under Appendix II (Mauritius hemp).

² Note this rise, also with manila, but not so much with Mauritius hemp.

MAURITIUS HEMP.

APPENDIX II.—PRICES OBTAINED PER TON ON THE LONDON MARKET, 1895-1904.

	1895	1896	1897	1898	1899	1900	1901	1902	1903
January ...	£ 15 to 25	£ 13 to 20	£ 13 to 21	£ 15 to 22	£ 21 to 26	£ 35 to 36	£ 20 to 27	£ 30 to 36½	£ 26 to 36
February ...	15 ,, 25	13 ,, 20	12 ,, 21	15 ,, 22	22 ,, 28	20 ,, 26½	22 ,, 27	30 ,, 39	26 ,, 35
March ...	16 ,, 25½	13 ,, 19	13 ,, 23	15 ,, 22	30 ,, 31	34½ ,, 35½	20 ,, 27	30 ,, 37	26 ,, 35
April ...	14 ,, 24	13 ,, 20	13 ,, 22	16 ,, 22	26 ,, 31	34½ ,, 35½	21 ,, 27	31 ,, 38	30 ,, 35
May ...	14 ,, 24	13 ,, 19	13 ,, 22	16 ,, 22	24 ,, 30	32 ,, 35½	21 ,, 27	31 ,, 38	30 ,, 37
June ...	14 ,, 24	13 ,, 19	15 ,, 22½	19 ,, 25	24 ,, 30	26 ,, 33	21 ,, 27	28 ,, 36	30 ,, 37
July ...	14 ,, 23	12 ,, 18	16 ,, 23	22 ,, 26	27 ,, 29	26 ,, 34	20 ,, 27	25 ,, 35	28 ,, 36
August ...	14 ,, 21	12 ,, 17	16 ,, 23	20 ,, 24	31½ ,, 32½	24 ,, 31½	20 ,, 26	25 ,, 36	28 ,, 35
September ...	14 ,, 21	12 ,, 17	16 ,, 23	19 ,, 24	31½ ,, 32½	22 ,, 30	20 ,, 27	28 ,, 36	28 ,, 35
October ...	14 ,, 21	12 ,, 21	14 ,, 22	21 ,, 26	32½ ,, 33	22 ,, 27	24½ ,, 31	30 ,, 37	27 ,, 34
November...	13 ,, 20	13 ,, 21	14 ,, 22	21 ,, 27	36 ,, 37	20 ,, 26	30 ,, 35	27 ,, 36	28 ,, 36
December...	13 ,, 20	13 ,, 21	15 ,, 22	22 ,, 27	35½ ,, 36	18 ,, 26	30 ,, 37	27 ,, 36	26 ,, 34

The prices in 1904 have been as follows: January, £26-34; February, £26-35; March, £26-35; April, £26-35; May, £26-34; June, £26-33; July, £24-33.

¹ Note this substantial drop. It will be seen that sisal and manila hemp show the same big drop in this same month and then recovered.

MANILA HEMP.

APPENDIX III.—PRICES OBTAINED PER TON ON THE LONDON MARKET, 1895-1904.

	1895	1896	1897	1898	1899	1900	1901	1902	1903
January ...	£ 18 to 18½	£ 17½ to 18	£ 18	£ 17½ to 17¾	£ 26	£ 65 to 67	£ 30	£ 46½ to 47	£ 35 to 36
February ...	18 ,, 18½	17½ ,, 18	16	18 ,, 18½	27 to 27½	31 ,, 32	32 to 33	49 ,, 50	35 ,, 36
March ...	18 ,, 18½	17½ ,, 18	16	18½ ,, 19	32 ,, 32½	56 ,, 58	34	47	36 ,, 37
April ...	18 ,, 18½	17½ ,, 18	15¾	19 ,, 19½	31½	56 ,, 58	32½	45	35 ,, 36
May ...	18 ,, 18½	17 ,, 17½	15¾	33 ,, 35	30½ to 31	46 ,, 49	33½	43 to 44	35 ,, 36
June ...	18½ ,, 19½	17 ,, 17½	15	34 ,, 34½	35 ,, 35½	38 ,, 39	32 to 33	40 ,, 41½	34 ,, 35
July ...	18½ ,, 19½	16¾ ,, 17	15	20 ,, 30	31 ,, 32½	39 ,, 39½	32 ,, 33	39 ,, 39½	33½ ,, 34
August ...	18½ ,, 19½	16¾ ,, 17	15½	29½ ,, 30	46 ,, 46½	37½ ,, 38	32	41½ ,, 42	35
September ...	18½ ,, 19½	18¾ ,, 19	14½ to 15	29 ,, 29½	46 ,, 46½	32	37½ to 38	42 ,, 42½	37 to 38
October ...	18½ ,, 19½	18 ,, 18½	15	32½	58 ,, 60	27 to 27½	42½ ,, 43	42½ ,, 43	36 ,, 37
November ...	18½ ,, 19½	18½	15¾	28	60 ,, 61	31 ,, 32	47 ,, 47½	41	38
December ...	18½ ,, 19½	18	16½ to 16¾	25	64 ,, 66	30 ,, 31	45½ ,, 46½	37	40 to 41

The prices in 1904 have been as follows: January, £40-41; February, £40-41; March, £40-41; April, £39-40; May, £35-36; June, 35½-36; July, £36½-37½.

CHAPTER II

QUEENSLAND

By A. J. BOYD

IN compiling this report¹ on the cultivation and preparation of the sisal plant and fibre, I am actuated solely by the desire to establish an industry which, in all other countries where it has been introduced, has put thousands, aye, even millions, of pounds sterling into the pockets of planters and farmers, besides furnishing a considerable revenue to the countries interested. I write in the hope that my readers will lose no time in taking up the matter, and, as many are now doing, in starting the cultivation of sisal. Those who do so may rest assured that as things are to-day (August, 1910) they will reap a rich return for their enterprise. It has been so in all sisal-producing lands, and it will assuredly be so here in Queensland. Before going further, I wish to dispel two notions which have been brought under my notice whenever I have advocated the planting of this aloë—one is, that increased production will result in unremunerative prices; and the other that, owing to the wonderful vitality of the plant, it may become a pest like prickly pear, *Sida retusa*, and lantana.

These fears may be at once dismissed. The sisal hemp market, for the past twenty years, shows that the demand is constantly increasing. The greater the production the greater the demand. Phenomenal prices, such as those of 1890, when the price ran up to £50 15s. per ton, have been obtained. But I

¹ Third edition, published 1910.

would point out that such exceptional prices have been the result of "Trusts," and cannot for a moment be regarded as a regular market price. If, with the market as it is at present, the planter obtains £25 per ton for the product, there remains a big margin of profit, as I shall presently show when dealing with the returns of plantations in Yucatan, the Bahamas, Florida, Mauritius, and other tropical countries. The enormous trade done in these countries, and the ever-increasing demand with which the production has not yet been able to keep pace, the expansion of the wheat-growing industry, for which millions of pounds of binder twine are needed annually, and, of late, the alarming decrease in the production of Manila hemp (*Musa textilis*), all tend to show that those entering upon the sisal hemp industry cannot fail, if they go into the matter in earnest, to reap a rich reward. With the pest question I will deal at length later on (see p. 101) under the head of "The Enemies of the Sisal Plant."

SOIL, CLIMATE AND TEMPERATURE

Our climate is identical with almost all climates of the world except the polar climates. The Queensland farmer can select a district which is very humid, where the rainfall may be reckoned in fathoms; he may take land in a district where the rainfall amounts to as little as 30 in. annually, or he may find whole districts, mostly coastal, where the annual rainfall is equably distributed throughout the year, and enables him to produce almost all the products of the known world. The shade temperature of Queensland ranges during the summer months from 70° to 100° F., and in winter from 28° to 70° in the south and on the tableland. In the far north the climate on the coast is absolutely tropical, and in the central districts sub-

tropical. Thus, within the latitude of from 12° to 29° , which includes the State, all the climates of Southern Europe, Florida, the Bahamas, Yucatan, Mauritius, South Africa, India, and the West Indies may be found.

In the following pages I have given all particulars possible concerning the industry, both from my personal experience and observation, and from authentic reports from reliable authorities who have had long experience in the Bahamas and Yucatan, as well as in Hawaii.

The climatic conditions of Queensland are so favourable to the growth and development of the plant that even better results may be assured to the grower here than are recorded of other countries. We have also the very best varieties of the true sisal Agave of the Bahamas, and of the Fourcroyas (*Furcræa*) from which are produced the sisal fibre of Yucatan, and the hemp known commercially as Mauritius hemp. There is, as I shall show, nothing to fear for the industry, either from labour conditions, or from fire, frost, flood, drought or disease. As far as frost is concerned, the Sisal Agave grows luxuriantly on the Darling Downs, at the State Farm at Westbrook, where the mercury falls to 15° F. night after night, yet even the youngest plants are uninjured by such intense cold.

From an orange grove of from 5 to 20 acres, or from a similar area of pineapples, Queensland farmers are enabled to make a very comfortable livelihood, but at present their market is restricted to Australia, and there is heavy competition at certain seasons of the year with New South Wales, and with portions of other States of the Commonwealth. In Cuba, Florida, the West Indies, &c., the business of citrus fruit and pineapple growing is being overdone, and cotton and sisal hemp are being called in to the rescue.

Here, in Queensland, we shall find a similar state of affairs unless the population of the various States is greatly increased by immigration. Even now, during the months of May and June, the price of oranges is so small that it only pays the owners of orchards where there are numbers of trees at least six or seven years old. I, myself, sold splendid oranges at 2d. per dozen in June, 1906, and had to find cases and cart the fruit 12 miles to market. Orange trees, however, which yield an average of £1 per annum will, for a long time to come, pay the orchardist handsomely; but consider the troubles he has to encounter in producing a crop, the enemies he has to contend against in the shape of fruit fly, orange moth, scale insects, and fungus pests; and the labour and expense which these entail to keep in check. Again, the grafting, budding, pruning, spraying and cultivating incident to the industry are never ending, and to these may be added the heavy items of manuring and irrigation.

All these expenses and worries are absent in connection with the sisal industry. There is, as I shall show, no necessity whatever for cultivating the sisal plant once it is established in the ground. On the contrary, it has been conclusively proved that planting in rich soil, manuring, and ploughing the ground are detrimental to the production of fibre, and the ploughing entails an actual loss to the grower, owing to the destruction of thousands of suckers which, for several years to come, will prove a source of income to planters, thanks to the great demand for plants which at present far exceeds their ability to meet.

SUGGESTED COST OF PRODUCTION IN 1910.

As far as profit is concerned, putting the expenses at the extreme, and the fibre at the lowest price

obtained in a series of years in New York, the principal market for the world's production of sisal fibre—viz., $4\frac{1}{2}$ cents, or $2\frac{1}{4}$ d., per lb.—which is equal to £20 19s. 8d. per ton, sisal hemp will give a clear profit of from 50 to 70 per cent.¹

One important point is that, comparatively speaking, the machinery required for preparing the fibre is remarkably cheap, compared with other crops. For instance, take the machinery for the production of sugar, this costs anything from £25,000 to £100,000 and even the simple machinery for the preparation of arrowroot will run into £2,000.² Where irrigation works are installed for the irrigation of cane fields, these cost from £300 or £500 for a tube-well installation to £40,000 for a pumping plant. If the water supply fails, or a severe drought occurs, the loss to the sugar-planter, the dairy farmer, the pastoralist, or orchardist, is enormous, often bringing irretrievable ruin in its train. The most expensive machinery for 100 to 500 acres of sisal costs but £500, and the motive power another £500, and none of the many accessories indispensable to the production of marketable sugar are needed for the preparation of the fibre. With this matter of machinery I shall deal fully in another portion of this paper. What I would particularly emphasize in this introduction to the subject is, that sisal-growing, unlike that of most other farm crops, demands no special agricultural knowledge on the part of the planter. The whole work may be summed up in a few words: Keep the young plants clean. Treat them, when planting, according to the directions here given. Never let them be choked

¹ In face of this and similar statements, it has been thought best to include Dr. Mann's table of prices to show how values ran during the years 1895-1904, not only for sisal, but for Manila and Mauritius hemp as well.—H. H. S.

² In Queensland but not in St. Vincent, B.W.I.—H. H. S.

with weeds or over-shadowed by brush. There is then absolutely no risk whatever of failure in an industry in which, as I have said, no knowledge of agriculture is required, yet which is so important an item in the exports of several countries that its value is reckoned, not by thousands, but by millions of pounds sterling.

THE PLANT AND ITS NATURE.

The hardy nature of the plant is almost incredible. Root one up, and it will remain green and be ready to take root again if planted months afterwards. There is no possibility of the failure of a crop once it is planted. Let it rain or not ; let the weather be bad, the sisal will hold its own ; it flourishes under all conditions. Even a hailstorm, unless exceedingly severe, will not inflict irreparable damage on the matured leaves. I cleaned some leaves of a large plant which had survived a heavy hailstorm, and found the fibre scarcely damaged. Dry weather has the effect of producing more fibre and less fleshy matter or "bagasse," as the waste may be called, and the plant gives its daily yield, always preserving its freshness, requiring neither ploughing nor manuring. Few, if any, animals will eat it. I have seen a mob of "brumby" horses on a plantation on several occasions, but never were any sisal plants eaten down, although several were kicked out when the horses were being driven off. Goats will occasionally nibble off the central leaf of a young plant, and, during the great drought, cattle would defy the spikes on the points of the succulent leaves, and devoured them in spite of the acrid juice which stings all living flesh it comes in contact with. Another thing in favour of a sisal crop is, that there is no particular harvesting or planting season. Whether planted in January or June, it is all the same to this accommodating plant,

although it is only reasonable to consider that planting in the spring time will get the plants on quicker than if they are planted in the autumn or winter. If the farmer is too busy with other work to attend to getting off the sisal crop, it will oblige him and wait until he is ready, without any injury to the fibre, but—once the leaves have been cut, they should be put through the machine within twenty-four hours, for if this be not done the grower will discover that even sisal leaves will not await his convenience once they have been removed from the plant.

When the first crop has been matured, the work of harvesting is continuous; there is no interlude. As the cutters work through the field, the plants already treated are busy maturing fresh leaves, which will be ready before the last ones are cut, and so the process goes on year after year without intermission.

I have considered these introductory notes necessary because so many inquiries reach the Department of Agriculture, all demanding nearly the same information as to the advisability of entering upon the industry. One question is constantly asked—

IS THERE ANY DANGER OF THE PLANT
BECOMING A PEST?

Will it spread over the land like the prickly pear, the lantana, or the *Sida retusa*?

A consideration of the nature of the plant and the method of its propagation will at once dispel this fear. Both the agaves and the furcræa (which latter is not an agave or aloe) belong to the order Amaryllidaceæ. These are reproduced in two ways. One by the numerous suckers which spring from roots of the parent plant; the other, by the fruit, if I may so call it, of the flower pole. The suckers are removed

either to form new plantations or for sale, or else they are destroyed. There is not the slightest difficulty in removing them, even when twelve months old. The "bulbils," as the fruit of the flower pole is called, are produced in large numbers, but there is no seed which can be properly so called. The bulbil is produced from the flower as a perfect plant, forming leaves and roots before falling to the ground. No bird is capable of feasting on such a production. If an ostrich or an emu were to swallow a thousand bulbils, these would be dissolved by the gastric juices of the bird's stomach or crop, and no seed is there to become a plant once it has been assimilated by the animal. The case is quite different with the three pests mentioned. The prickly pear has a fruit full of seeds. This fruit is eaten by many birds, and the seed is thus carried all over the country. Every portion of a prickly pear leaf will grow if thrown on the ground. Allow a leaf to root from one of its faces; dig it up and turn those roots to the sun, still the leaf will produce more roots on the other face, and will continue to grow. So with lantana. This bears a succulent fruit, laden with seeds much appreciated by birds, which act thus as propagators of the pest. The *Sida retusa* bears countless seeds, which are carried about in various ways, particularly in the hoofs of stock. Now, the leaf of the agave and fourcroyas, or furcræa, once detached from the mother plant, shrivels and rots. There is thus no possibility of the plants being propagated by leaves or birds. If a plantation were to be abandoned, still there is no danger of the plant spreading to any injurious extent. The plantation itself would become choked with suckers and bulbils from the flower pole. But once a plant has flowered, all the suckers attached to that plant send up small poles, and both mother plant and suckers die a natural death. As to the lateral spread of the plants, that is

easily kept in check. Our incipient plantations are all in farming or sugar districts, yet we have never heard of any farmer complaining that his neighbour's plants are encroaching on his cultivation. The *Furcræa* of various kinds has been growing in Queensland in many parts of the country for over forty years, yet it has never spread, nor is it likely to do so.

There is an additional reason for feeling secure in this matter. One of the functions of a department of agriculture is to guard the country against the introduction of animal and vegetable pests, yet in all tropical and sub-tropical countries the agricultural departments advocate the planting of sisal hemp, and no Minister would for a moment do this if the plant were at all likely to become a menace to the land.

DESCRIPTION OF THE PLANT AND ITS VARIETIES.

The sisal fibre of commerce is the product of one of the agave or aloe family, belonging to the natural order Amaryllidaceæ. There are several species, and all were originally natives of Central America, and chiefly of Mexico, whence the old name of "Mexican Sisal Grass." They are now, however, widely acclimatized in many warm, temperate, sub-tropical, and tropical countries. They take several years to reach the flowering stage, the term varying from 6 to 50 and even to 100 years, and owing to this they received the popular name of Century Plants.¹

As stated, there are several varieties of the sisal plant (*Agave rigida*), and of these seven are grown

¹ Even were a 100-year-old plant to be a fact, would the fibre be of use, or, like an old man of such an age, would it have passed its age of usefulness? On p. 215, in the Section devoted to Hawaii, mention, however, is made of plants in Yucatan as yielding fibre when 50 and 60 years old and even older.—H. H. S.

for commercial purposes in Yucatan. There is no longer any reason, except custom, to call the agaves by the name of "sisal." This title was given to the *Agave rigida* by the American Consul, Dr. Perrine, who first introduced the plant into Florida, simply because the principal port of Yucatan peninsula from which the fibre was at that time exported was the town of Sisal. Sisal has of late years been abandoned as a shipping port for the fibre in favour of Progreso. We might, therefore, with equal reason describe one variety of the plant as *Agave rigida*, var. *progresana*, as we now designate it var. *sisalana*. However, that is a matter of very small importance. The history of the rise of the sisal industry in the Bahamas is very interesting.

SISAL IN THE BAHAMAS

When Sir Ambrose Shea was Governor of this British colony, and even before that, in the time of his predecessor, Sir Henry Blake, the sisal plant was growing luxuriantly in the islands. How it came there, or who introduced it, I cannot say, but it thrived so remarkably that the colonists became alarmed, thinking it would prove eventually a curse to the land. Organized efforts were made to eradicate it, but the tenacity of the plant was amazing. The more determined the people of the Bahamas were to get rid of it, the more the vigorous aloe held its ground, and, fortunately for the islanders, it so continued to flourish that they abandoned all attempts at destroying it.

About this time tales of vast fortunes which had been and were being made in Yucatan by sisal growers reached Sir Ambrose Shea, and these tales seemed so incredible that this sensible Governor sent a special commissioner to Mexico to ascertain the truth. This commissioner's report fully confirmed all these tales, and it is consequently not surprising that,

even in spite of his full corroboration of the stories of fortunes made in Mexico by all growers of sisal, there should have yet remained some incredulity in the Bahamas, especially as the Yucatan plant was described as inferior to the despised product of the Bahamas. This latter, by the way, is the plant which was originally imported into Queensland by Mr. P. McLean, at one time Minister for Lands, and afterwards for many years Under Secretary for Agriculture, and later on Agricultural Adviser in Queensland, and which is now being distributed over the State from several plantations originally stocked with plants from the Penal Establishment at St. Helena, in Moreton Bay.

Finally the people of Bahama took up the industry, to such advantage that within two years the exports of fibre reached the respectable total of £130,000 annually. This despised plant raised the colony to a high state of prosperity, changing the place from a hopeless condition of depression to one of bounding advancement. Land rose from 5s. to 16s. 8d. an acre, and the Governor determined to sell no more land, but to reserve it for immigrants at 5s. per acre, payable out of the proceeds of the first crop.

The total cost of producing a crop of sisal in the Bahamas, from the start, is from £10 to £12 per ton, which at once shows the immense profits which can be realized. The first export of sisal from the islands took place in 1892. In 1910, the cost of producing a ton of sisal fibre in Queensland by white labour was £12.

YUCATAN AND HER VARIETIES.

The seven varieties I have mentioned as being grown in Yucatan are thus described in a work on sisal-planting, now out of print, by Mr. D. J. Stoddart, a well-known resident of Jamaica:—

Chelem.—This is grown in the rocky, sandy districts of the north-west, where it is also found in a wild state. It is very much like the *Agave angustifolia*. This is considered one of the best varieties, owing to the brilliant whiteness of the fibre and its strong texture.

Sacci or *Sacqui* (pronounced sacki) is, however, the most extensively grown. The name means, in the Indian dialect, "white," because the light-green leaves are covered with a white, waxy bloom. It grows in all parts of Yucatan, but mainly in the north-west, in the further districts of Merida. It has long leaves, with prickles on the edges, and yields more of them than any other kind. The fibre possesses all the qualities of quantity, flexibility, whiteness, strength, length, and weight.

Yaxci or *Yaxqui* (pronounced yashki) takes the third place in the estimation of planters. The word means "green-leaved." The leaves are shorter than those of some other varieties, and they yield a small quantity of filament, which is soft, fine and strong. Another writer says that the fibre is more elastic and lustrous than any other, and obtains the highest price in Europe. This variety is grown in the east and south of Yucatan only. It requires a better soil, and is grown on old sugar lands. A damp climate suits it best. The fibre is much in demand for fine dress material.

Chucumci (pronounced tchukumki) comes fourth in order of merit. This plant much resembles the sacqui, but its leaves are harder and thicker, and it yields a coarser, rougher, and less flexible fibre, only suitable for the manufacture of coarse articles. It is, however, widely grown on the rocky, sandy plains of the coast.

Babci, the fifth variety, in the planter's estimation, is more akin to Chucumci than to Sacqui. It grows

quicker, and yields twice as many leaves, but they are much smaller, and produce but a small quantity of fibre of good quality.

Citamci or *Quitamqui* (pronounced kitamki) is one of the poorest of the agaves. It has short, thin leaves, producing little fibre, and is therefore not appreciated.

Cajun (pronounced cahun) is properly not an aloe, but belongs to the *Furcræa*. Its principal representative is the *Furcræa gigantea*. It has thick, fleshy, narrow leaves, about 4 ft. long; is light-green in colour, and possesses no prickles either on the edges of the leaves or on the points. It grows wild on the coast, close to the mangrove belt. In Queensland, there are several varieties of the *Furcræa*. *F. Lindenii* produces broad, smooth leaves, often 9 ft. long. The fibre has none of the lustre of the true sisal fibre, neither does it possess the strength or weight of the latter. The leaves grow more rapidly, and are ready to cut long before those of the sisal plant have matured. In Yucatan, the sacqui leaf grows to a length of from 4 to 5 ft., with an average weight of nearly 2 lb. Notwithstanding the presence of the spines on the edges of the leaves, it is preferred above all other varieties. It is the *Agave rigida* var. *elongata*.

The variety at H.M. Penal Establishment at St. Helena, Queensland, and at Peel Island, Moreton Bay, as well as at Bajool, on the North Coast Railway line, near Rockhampton, and which has been distributed far and wide over the State, is the *Agave rigida*, var. *sisalana*. It originally came from the Bahamas, where it was distributed by Sir Henry Blake when he was Governor of the colony. So great a future for the industry was apparent after a time that the Government was induced to forbid the export of any plants for three years.

The plant is easily distinguishable from the *sacqui*,

as it is of a dark-green colour, and has no spines on the edges of the leaves. There is, however, one strong, sharp thorn on the point of each leaf. The absence of thorns saves much trouble, expense, and difficulty in harvesting the leaves.

THE QUESTION OF SUITABLE SOILS.¹

The most suitable lands for the cultivation of the sisal plant are poor, rocky, dry, gravelly soils, rich in lime, worn-out sugar-cane and arrowroot fields. Swampy land must especially be avoided. In such localities, the plant will drag out a miserable existence and eventually dies. I have seen plants growing in soil that was constantly wet. The leaves had a sickly yellow look, and before five years the flower pole appeared and the plants rotted away.

A very suitable soil is one composed mainly of coral rock. On this question of soil I will quote several authorities.

Mr. Consul Leay, in a report on Vera Cruz for the year 1903, writes: "The agave flourishes on arid land, where the soil is very thin, resulting in the strength of the plant being driven into the leaves instead of into the roots, while the latter appear to run along the surface, and from these the shoots are produced, and, in turn, planted."

Mr. Cameron, of the Botanic Gardens, Bangalore, says: "The soil recommended is poor, loose, stony ground. The plant grows larger in rich land, but the fibre is less in quantity and quality."

To show how rapidly the sisal fibre industry increases in some countries, I will instance—

¹ The reader must carefully study the various opinions given throughout the book on ideal soils before forming any definite opinion, and even then will be wise to arrive at his own conclusions.—H. H. S.

THE CAICOS ISLANDS.

These islands are a group lying to the south-east of the Bahama Group, about 400 miles east of Cuba.

As will be seen, by far the most important of the industries of the Caicos Islands is that of sisal fibre, which is of comparatively recent introduction into the Dependency. Captain (now Sir H. M.) Jackson was the first Commissioner to direct practical attention to the possibilities of this plant, for he sent on to Kew specimens of the Pita found in the Caicos, which were identified as the sisal of commerce. The seedlings of the original plants are said to have been brought from Crooked Island in the Bahamas to the Caicos Islands by Mr. Henshall Stubbs about the middle of the last century, but it was not seriously cultivated for export purposes until 1890, when two companies at West Caicos and East Caicos were formed and registered under the Trading Companies Ordinance. Despite the inevitable initial discouragements and difficulties, these companies have struggled on and have proved the practical salvation of the Caicos Islands. Prior to the commencement of the cultivation of fibre, the chief occupations of the people had been wrecking and primitive cultivation of ground provisions. The erection of the Grand Turk lighthouse had deprived them in a large measure of their chief source of livelihood, and one of the Commissioner's predecessors had quaintly to lament, in enumerating the disasters of the year, that there had been only three wrecks. As the soil in the Caicos at the best is shallow in the extreme, the crops in the frequent seasons of drought were absolute failures, so that the Government had almost yearly to send relief in the form of food to the half-starving people dependent, as has been said, upon crops which, in most favourable years, could with difficulty, satisfy their wants. Coming at an oppor-

tune time, the fibre industry gave steady employment and established habits of industry in place of precarious and demoralizing conditions of work to the people, who were rapidly relapsing into semi-savagery. At the present moment 250 to 300 persons are regularly engaged in the fibre cultivation, and in addition to the two pioneer companies already mentioned, several persons belonging to the Dependency have commenced planting fibre, and are increasing the area of cultivation as quickly as their limited capital will allow. A rough estimate, as follows, may be given of the land now planted in sisal :—

East Caicos	...	...	...	2,000	acres
West Caicos	...	...	...	1,000	"
Bellevue, North Caicos...	...	...	...	150	"
Haulover, Grand Caicos	...	...	...	50	"
				3,200	"

At East Caicos 1,000 acres more are to be planted in the near future, while there will still remain about 3,000 acres for future development. In West Caicos there are about 4,000 acres belonging to the company suitable for sisal, and 600 acres of Crown lands are also to be leased. At Bellevue and Haulover there are 1,500 and several thousand acres respectively. In the Turks Islands, the recent unfortunate experience in the salt industry has clearly indicated the importance of introducing fibre to afford, during wet seasons, employment to the labourers, and prevent their wholesale emigration, and two leases of Crown lands of 430 and 350 acres in Grand Turk and Salt Cay, respectively, were signed about two years ago. These leases, which are for twenty-one years, with the option of renewal for a further term of twenty-one years, stipulate that the lessees shall within three years commence the cultivation of the land, and within five years have at least so many acres under cultivation as are approved by the Government. In the Caicos

Islands there are thousands of acres suitable for sisal cultivation, which, being surveyed can be either sold or leased on conditions similar to those already stated.

The following figures, showing the progress of the industry in the Caicos Islands, should give great encouragement to Queensland planters :—

Exports of Sisal Fibre from 1890 to 1906.

	£		£
1887	—	1897	2,539
1888	—	1898	2,902
1889	—	1899	7,494
1890	50	1900	5,081
1891	11	1901	6,551
1892	25	1902	7,101
1893	—	1903	6,488
1894	420	1904	6,887
1895	620	1905	5,803
1896	1,047	1906	5,605

In 1907 a prolonged drought, and hurricane in 1908, had a disastrous effect on the sisal crop in the Caicos, the export value being reduced from £5,602 to £3,197 in the former year, and to £1,664 in the latter.

NATAL

Some time ago, Mr. T. R. Sim, F.L.S., Conservator of Forests in Natal, made inquiries in England on the occasion of the South African Products Exhibition, concerning the fibre industry, which it might be possible to develop in Natal. On his return to Africa, he furnished the following report to the Minister for Agriculture in Natal :—

The term “aloe fibre” is incorrect, inasmuch as the product is not produced by “aloes” but by different species of agave and furcræa, though in a general way these resemble aloes in habit and appearance; and one species of agave is widely known in cultivation under the common name of

American aloe, though not a true aloe. The term "aloe fibre" is also vague, since it covers the product of many species, and of at least the two genera mentioned above, so it is advisable to drop it and use the more exact common names sisal hemp and Mauritius hemp, though unfortunately these well-known and fully-established common names are also somewhat misleading, since neither plant is related to hemp except in that it produces a somewhat similar fibre.

The botanical differences between these plants of somewhat similar habit is that aloe belongs to the order Liliaceæ, characterized by having the petals rising from the top of the ovary (seed vessel), while agave and furcræa belong to the order Amaryllidaceæ, and have the petals rising from below the ovary. Agave has the stamens longer than the perianth (petals), and the style threadlike, while furcræa has the stamens shorter than the perianth, and the style thickened below the middle.

The species of aloe are not producers of fibre fit for economic purposes, but many species of agave and furcræa are so. Both agave and furcræa are represented by many species, mostly natives of Mexico and the adjoining districts of North and Central America, as shown by the following figures from the *Index Kewensis* :—

	Agave species	Furcræa species
Mexico	124	5
Texas, California, and Arizona ...	9	—
Central America	4	4
South America	4	3
West Indies	3	—
Malaysia	3	1
Madagascar	—	1
Horticultural hybrid	1	—
Doubtful	4	5
	—	—
	152	19

Many of these species have never been seen in flower ; some of them vary much in having within the the same species forms with and others without thorns on the side of the leaf, or a spine at its point ; all resemble one another in a general way, and some of them do so very closely ; all produce fibre, but they vary exceedingly in the quality and percentage of fibre ; while even within any one species the percentage of fibre varies immensely in accordance with local surroundings. In Mexico and the West Indian Islands many species produce fibre which is sufficiently good to be a commercial commodity, and this is so much alike that it is shipped as one kind, but of varying qualities, in accordance with the preparation it has received. A few years ago it was doubtful which species yielded the valuable fibres, and which were not worth cultivation for fibre ; even now few men know more than a few of the kinds, and the resemblance between good and comparatively useless kinds is so great, and each varies so much in accordance with its surroundings, soil and climate, that the risk is very considerable of getting hold of a wrong kind under the right name, and cultivating it for several years before the error is found out. For instance, Mr. I. G. Baker, in describing *A. decipiens* which was found to form half the crop in some Florida plantations, and was also introduced into the Bahamas as sisal, remarks : "The fibre which it yields is very inferior in tenacity to that of *A. sisalana*. I cannot make out any material difference between the flowers of the two species. The name *decipiens* refers to the plant being confused so easily with the forms of *A. rigida*, of which the fibre is so much more valuable that it would lead to loss and disappointment if the former were cultivated for economic use." Furcræa as grown at Durban and Port Shepstone differs so much from that grown at Maritzburg as to lead to doubts

about their being identical, while the latter resembles almost as closely the agave grown in Durban under the name of sisal hemp, and to the casual observer might readily be passed as such. In India much confusion existed some time ago regarding the various species of agave and furcræa, as shown in Watt's "Dictionary of Economic Plants of India," *Agave americana* even being at that time thought to be a contributor to the supply of fibre of this class.

AMERICAN ALOE.

What we know as "American aloe" in South Africa, the hardy, somewhat glaucous kind, commonly used as a rough hedge, even in the upper districts, of which one or more variegated forms are in common cultivation as ornamental plants, is not yet botanically identified with certainty. It has usually been considered to be *A. americana*, but recent investigations throw considerable doubt on *A. americana* being so widely spread as supposed, and it is possibly *A. vera-cruz* or some other allied species. With this doubt as to its identity comes an equal doubt as to its fibre value. Some species in this group have valuable fibre, in others the fibre is comparatively worthless, and though about thirty years ago a factory for working this fibre was established at Grahamstown, the supply of leaves being obtained from the single lines of "American aloes" used as hedges for miles around—that supply soon became exhausted, and the industry succumbed without leaving on record what was the value of the fibre or the cost of growing and working it. It has a fibre, certainly, which suits an up-country native for cordage, but whether or not the plant is worth cultivation for its fibre may be said to have never been properly tried. It has a comparatively small number of leaves; these are difficult to work on

account of weight and prickles and thickness, and probably a small percentage of fibre, but against this is the fact that it grows freely all over South Africa and propagates so rapidly from suckers, though it does not form bulbils.

In the first volume of the *Imperial Institute Bulletin* are frequent and favourable references to Indian samples of what are called *A. americana* and American aloe ; but in regard to the Indian species it is to be noticed that recent authorities doubt the presence of *A. americana*, though its viviparous nature also raises doubt as to its being identical with the South African kind. In one of these references it is stated: "The fibre of *A. americana*, it may be mentioned, when made into ropes is stronger than Russian hemp, and the paper manufactured from it is tougher than Bank of England note paper."

SISAL HEMP.

The fibre product of Yucatan (which produces more fibre of this nature than all other countries together) is largely that of *Agave rigida*, var. *sisalana*—or, as it is often written, *Agave sisalana*—and the name sisal hemp of commerce includes along with this the other agave and furcræa products of America and its islands. Various local names are in use, but to the commercial purchaser they are all merged, and he buys on the quality.

In Florida the true sisal (*Agave sisalana*) is in cultivation along with several other kinds ; in some of the West Indian islands sisal has been introduced and is cultivated to a considerable extent, in others local species are used, and it is now known that there are many species so used in these islands. Concerning German East Africa and the prospects of Natal, Professor (now Sir Wyndham) Dunstan, Director of the Imperial Institute, writes me: "The German

authorities sent their officers to Mexico and Florida, and in 1893 a plantation was made, containing about 63,000 plants. In 1904 the plantations at Kikogwe and Muera extended to about 3,460 acres, and contained nearly 2,000,000 plants. Plantations have also been established in other districts. In 1905 about 1,300 tons of fibre was exported, of the declared value of £50,000, which works out at an average of £38 10s. per ton. It is estimated that in a few years the sisal hemp produced will amount to 10,000 tons, and will represent a value of between £350,000 and £400,000 per annum. Extensive trials have been made in German East Africa of machines suitable for treating sisal hemp, and this problem appears to have been successfully solved. . . . My present impression is that sisal hemp will probably be the most profitable fibre in Natal. *Sansevieria* fetches a rather low price, and appears to present some difficulties in its preparation. *Furcræa* also is of inferior value to sisal, and from what you told me I should say there should be no difficulty in producing sisal in Natal of the same quality as that now so successfully turned out from East Africa."

In Natal there is at present very little of true sisal hemp. A good few years ago a small importation was received per post at the Botanic Gardens, Durban, and has been the parent supply of all now in the colony except plants imported within the past two years. A further and larger quantity imported to the same gardens as ship's cargo did not yield one plant. From the first consignment a number of suckers were sent to the late Mr. Watt, at Port Shepstone, and were the parents of the comparatively small number now to be found in that neighbourhood. A few have been grown in the Durban Botanic Gardens, and the stock kept up but not largely increased till recently, since there was previously no demand. There are

meantime some of these with flowering poles, and these are producing flowers and seeds as well as a few bulbils. These are not the original plants but suckers from them. A good many plants have recently been imported, mostly by German colonists here, from their friends in German East Africa. Questions having recently been frequently put as to where supplies of young plants of sisal can be obtained from, I have received through the courtesy of Colonel (now Sir David) Prain, Director of the Royal Botanic Gardens, Kew, and also from the Director of the Imperial Institute, addresses in Florida, West Indies, and India, from which plants are likely to be obtained. A communication on the subject has also been addressed by Government to the German East African authorities, but up to the time of writing no reply has been received. Fibre cultivation is assuming large proportions in that country, and it should be possible to obtain from them a supply of young plants. Mexico is, of course, the first source of supply which suggests itself to most growers, but on this Col. Prain states: "The people of Mexico, I understand, are not unnaturally averse to the establishment of a sisal industry in other lands, lest this should diminish their own profits. There are many other species of agave in Mexico, some of which, especially when the plants are young, closely resemble sisal, and yet yield but worthless fibre; the risk of being, either through carelessness or of set purpose, supplied with young plants that, when they grow up, prove not to be sisal at all, is so considerable that Mexico is to be avoided as a source of supply."

Col. Prain further adds: "I may mention that in India it has been found that the best distance to plant sisal is at 5 ft. by 5 ft. This gives 1,742 plants per acre. Therefore, for 100 acres 175,000 plants will be required. An importation even for 100 acres is thus

a formidable undertaking, and even if you decide to obtain young plants from all three sources (Florida, West Indies, and India) I am doubtful whether from any of them you could obtain, at once, anything like 60,000 plants, which would be approximately one-third the number required. When sisal was imported by the Government of India, fifteen years ago, 5,000 was considered a large importation.

“Another important consideration is whether sisal has been proved to thrive well in Natal. If this point has not been tested, I think it would be well to do so before undertaking so wholesale an importation as is suggested above. I think that perhaps at first it would be well at the outside to import not more than 15,000 plants—viz., 5,000 from Florida, 5,000 from the West Indies, and 5,000 from India, and to wait until the plants of the first importation reach the stage of poling, when sufficient young plants will be produced locally to supply the whole of Natal.”

Professor Dunstan also gives a caution on this. He says: “There is no doubt that the fibre of *Agave rigida*, var. *sisalana*, is superior to that of *Furcraea gigantea*. The latter fibre is finer and not so white, lustrous, or strong as sisal hemp. The yield of Mauritius hemp is about $2\frac{1}{2}$ per cent. of the weight of the fresh leaves, whilst that of sisal hemp is usually about 4 per cent. Moreover, sisal hemp is generally quoted at a somewhat higher price (usually £3 to £4 per ton more) than Mauritius hemp.¹ Before replacing the furcraea, which is already well established in Natal, by the sisal hemp plant, it would be desirable to ascertain by experiment the comparative suitability of the latter plant to the local

¹ In May, 1910, Messrs. Landauer and Co.'s (London) Weekly Market Report quoted Mauritius Hemp at £26 and Sisal at £27 per ton. Prime qualities of Mauritius were worth more than Sisal, but were unobtainable.

conditions of soil and climate, and the comparative yield of leaves and fibre obtained from the two plants."

It can hardly be claimed that the behaviour or yield of sisal hemp is already well known in Natal. The *furcræa* is widely distributed in Natal, and these particulars are known in regard to it, but in regard to sisal the fact that it lives in a few localities is about as much as we know locally, and the fact should not be overlooked that in other countries, and even in German East Africa, certain localities are found to suit *furcræa* better than sisal, and vice versa. In the annual report of the U.S. Department of Agriculture for 1905 (page 146), it is stated, in reference to Porto Rico, "There are considerable areas of dry, rocky, limestone soil very similar to that producing the best sisal plants in Yucatan and the Bahamas." These climatic and soil conditions probably are worth attention in regard to sisal.

The whole question seems to turn on whether the kind we have (*Furcræa*), and of which plants are easily and cheaply obtainable, is sufficiently good to go on with meantime, until these points are cleared up, and until a large supply of sisal can be raised locally, or obtained from East Africa or elsewhere on terms which are not prohibitive.

MAURITIUS HEMP

(*Furcræa*).¹

The answer to this appears to be that it alone has been sufficiently good to make the fibre industry of Mauritius—that is, if our plant is identical with that grown in Mauritius. This has been questioned, and as the source of our supply is quite unknown, it is just

¹ Fourcroya is incorrect, the earlier and, therefore, the correct spelling being as given above.

as likely to have been received from elsewhere as from Mauritius, and may be quite distinct, though it is certainly closely allied. Neither seems, so far, to have been botanically determined with certainty. This is a botanical point which requires clearing up. But this fact at least remains: that the sample bale sent to the S.A. Products Exhibition by the Natal Industrials, Ltd., from Port Shepstone, was reported on as follows by the Director, Imperial Institute:—

“The sample of aloe fibre from Natal which was forwarded with your letter of March 9 has now been examined at the Imperial Institute, with the following results:—

“The sample was labelled ‘Aloe Fibre, Natal, Major Silburn, Port Shepstone,’ and consisted of $5\frac{1}{2}$ oz. of fairly lustrous white fibre, which was fairly well cleaned and prepared. It was of fair but rather uneven strength. The length of staple was 4 ft.

“Chemical examination of the fibre gave the following results:—

	Per cent.
Moisture	9'3
Ash	0'9
a. Hydrolysis loss	12'7
b. Hydrolysis loss	14'7
Acid purification, loss	1'7
Cellulose	75'4

“The sample was submitted for commercial valuation to experts who described it as corresponding fairly well with ‘good, fair quality Mauritius hemp, and valued it at £26 10s. to £27 10s. per ton. At the time of this valuation Mauritius hemp was quoted in the London market at £25 to £30 per ton. The above results indicate that the fibre is of fairly good quality, and very similar to other samples of *Furcræa gigantea* which have been examined at the Imperial Institute.” Meanwhile, reports go to show that on

suitable land the failure of a crop has never been heard of.

The climate of the Yucatan peninsula is arid tropical, and the country, though its extremely rocky character renders it almost worthless for any other crop, from sisal fibre alone rapidly became, in proportion to its population, one of the richest sections of Mexico.

The plant is there often set out on rocky sites where there is absolutely no soil, the plants being held upright by pieces of coral rock, and the holes broken out by crowbars, and sometimes with the aid of dynamite. It thrives best on a soil composed chiefly of limestone. This has been conclusively proved in Queensland. Plants which were set out in the limestone soil outgrew those which were planted in better soil six months previously.

The main objection to planting on rich soil is that, in our semi-tropical climate, weeds and shrubs grow rapidly and overshadow the sisal plants, which demand all the air and sun-heat possible. The rich soil produces very large, fleshy leaves, with a disproportionately small quantity of fibre; and such a vast number of suckers are produced—as many as 150 at a time per plant—that unless they are removed they withdraw the nourishment necessary for fibre production.

Generally, suckers appear within twelve months of planting. Queensland plants have attained an age of eighteen to twenty months, with leaves 2 ft. long, yet only here and there are as yet any suckers to be found.

CULTIVATION.

The land having been selected, the next business is to clear it for planting. There is no need to grub the trees out by the roots. They may be simply cut

down level with the ground, so that the stumps may not afterwards interfere with harvesting, and burnt off in heaps. From these stumps shoots will be put forth in the spring and summer, which grow very rapidly, as anyone who has cleared land in this manner in Queensland knows well. The sisal plant, however, requires plenty of sunlight, therefore the shade afforded by this aftergrowth is most injurious. It must be cleared off at least twice a year, and by the end of the second year very little more will appear, as the stumps die off. The land should be fenced to keep off stock, but once the plants have taken firm hold, and are from 18 in. to 2 ft. in height, there is little danger to be apprehended from stock.

The plants to form the plantation should be obtained as young as possible, experience having shown that young plants, 10 or 12 in. high, or even less, do not fall back, but continue to throw out roots and leaves almost as soon as they are set in position, whereas older plants, 20 or 30 in. high, take much longer to make a start.

NURSERIES MAY BE NEEDED.

Should the land not be ready for the plants, a nursery must be prepared, and the young suckers planted 18 in. apart. When planting the young suckers, care must be taken to remove any dry leaves, cut the main roots completely off, and pare as closely to the trunks as possible all round, without injuring them, nor so deep as to allow the leaves to fall off. Then they should be placed in the ground perpendicularly, covering only the lower portion of the trunk. This work will well repay the planter, as the dressing of the roots advances the plants in their growth, lessens the subsequent production of suckers, and thus gives the plants greater vigour. The same precautions are to be observed in field planting. If the

plants are treated in the same manner as pineapple suckers—i.e., the dead leaves taken off and the old roots trimmed off—there will be no fear of their failing to take root.

PLANTING.

Whatever sized field is to be planted, it should be properly laid out in rows at the desired distance apart. Authorities differ on this question of distance between rows and plants. Some advocate rows of 12 ft. apart, with a space of 6 ft. between the plants; others, recommend 10 ft. by 10 ft.; others, again, think 8 ft. by 4 ft. not too close. It is, however, largely a question of soil. In rich soil the plants grow to a large size, and must, therefore, be allowed wide intervals. On poorer or on rocky soils they may be planted closer. One thing must be borne in mind, and that is, that suckers will have to be removed, and that in three or four years (in North Queensland) harvesting will begin. To carry on these operations with ease, there must be plenty of room for the workers. If, for instance, the rows are 8 ft. and the plants 6 ft. apart, when the leaves reach the cutting stage they will be from 4 ft. to 6 ft. long. *Furcræa* leaves will attain a length of 9 ft. It is easy to comprehend how completely the rows would be blocked up when the mature leaves assume a horizontal position. How then, it may be asked, can it be advised to plant at distances of 8 ft. by 4 ft? If it is desired to plant at such close quarters, it should only be done on the poorest ground. Then three rows may be planted. Leave a space of 12 ft., and plant three more rows; then again a space of 12 ft. There is, however nothing gained by this method. Except for experimental puposes, all my five fields are planted at intervals of 10 ft. by 10 ft. and 8 ft. by 8 ft. One exceedingly stony plot is planted 8 ft. by 4 ft., and

another small experimental patch of about half an acre, on limestone rock, is set out as close as 4 ft. by 4 ft. But, for regular planting, the distance between the rows should be 12 ft., and between the plants 6 ft., which gives 605 plants per acre; 10 ft. by 10 ft. requires 435 plants; on 8 ft. by 8 ft., 680. Planted at these distances, there will be plenty of room both to remove suckers and subsequently to harvest the leaves. A very good additional reason for wide planting is that the plants receive the full benefit of the sun's rays. In the remarks on the yield of fibre I have given a remarkable instance of the results of excessively close planting in Queensland.

Now, as to the method of putting in the plants.

Sisal hemp thrives best without any hoeing or ploughing. In Mexico, in the Bahamas, also in Mauritius, and in Florida, ploughs and horses or mules are not used, neither is even the hand hoe much in evidence. The machete, the billhook, the pickaxe, grubber, and even the crowbar, are all employed both for planting and cutting down undergrowth and tall weeds. I am informed that the same implements are used in after-cultivation of sisal hemp in Hawaii. I have seen the plant thriving in pot-holes in the solid rock in South America, and, on my own plantation, plants in very rocky ground have quickly gone ahead of those planted in alluvial soil. I have already, in the introduction to this work, pointed out the disadvantages attending the constant cultivation and manuring of the plant.

It will readily be understood that sisal plants should be put in the ground in a perfectly upright position, and all exactly the same distance apart, as this renders subsequent work easy, and the passage of carts or sledges carrying the leaves to the machine house will not injure the leaves on the plants, as would be the case if they were leaning over the cart-

way at an angle of 45° . Most of us have seen the destruction of sugar-cane by the passage of the steam locomotive and trucks on sugar plantations, when the permanent tram road is narrow and the cane well grown. At the same time, in very rocky land it will often not be possible to plant in continuous rows or even in straight lines. In such a case, advantage has to be taken of what I have already called "pot-holes." Very solid rocky spots will have to be left unplanted, and if a pot-hole is planted outside the straight line the corresponding hole on the opposite row should be left blank.

I reproduce here an example of the plan of laying out a field of $31\frac{1}{2}$ chains square, equal to nearly 100 acres, as given by Mr. D. J. Stoddart in his work on the sisal-growing industry, now out of print:—

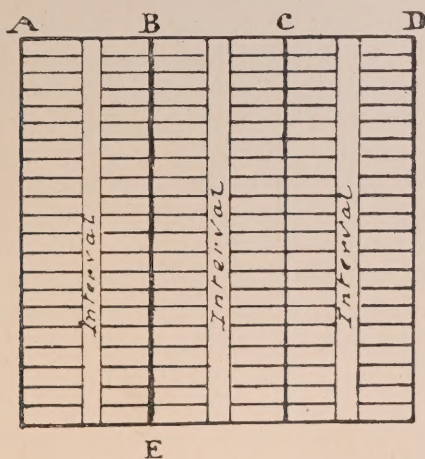


FIG. 3.—Laying out a plantation.

The field is divided into three sections, each of which measures $10\frac{1}{2}$ chains, and is represented as follows: A to B first section, B to C second section, C to D third section. In the middle of each runs an

interval of proper width having a depth on either side, within each section, of about 5 chains (chain = 22 yds.).

The short lines drawn across indicate the rows of hemp between which the cutter works, and who, therefore has—while cutting in any section—a distance of not more than 5 chains to carry the leaves to the interval, where the cart gets loaded. Each section has its boundary line, as is shown from B to E. It will be found, if this plan is adopted, how much the carriage of leaves is facilitated, being done quickly to the great interest of the cultivator.

COST OF HOLING, PARING ROOTS, AND PLANTING.¹

One man can dig out 200 holes, drop suckers, and plant them in a day. A young man on my plantation, in the summer of 1906, raised 250 plants from the nursery, dug and planted the holes, besides paring and dropping the plants, in one day. He charged 3s. 6d. for this work. The holes, it should have been mentioned, are only about 18 in. in diameter and 8 in. deep. Where the soil is hard or rocky, it is sufficient to make a hole large enough to receive only the rooting part of the trunk of the plant. As far as paring the plants is concerned, a man can easily pare 1,000 to 1,200 in a day. Mr. Stoddart says it is worth 4s. 6d. per acre of 605 plants, or 9d. per 100, to line out, dig holes, drop suckers, and plant, and that one man and a boy can plant at least 300 suckers or half an acre per day. It would, under ordinary labour conditions in Queensland, cost about 10s. or 12s. per acre in summer, and slightly more in winter when the days are shorter.

¹ Here, and throughout the book generally, the reader must remember the date when the information published was obtained, and make allowances with (when comparing them) present-day ideas.—H. H. S.

Planting may be carried on during any month of the year, but, as has already been said, the spring months, from August to October, should be chosen if possible, as showers may be expected, which will materially hasten the rooting of the plants and settling of the soil.

CARE OF THE PLANTS.

Once a field is planted it may be practically left to itself, as there is probably no crop, except, perhaps, the castor-oil plant, which requires less care to bring it to perfection, or which grows under more apparently adverse circumstances than sisal. At the same time, a little care at the outset will always be responded to by the plant. One of the most annoying weeds is couch grass. This is usually rampant on land which has been cultivated. It should never be allowed to make headway in a young plantation, as it twines round the young plant, roots itself firmly amongst the sisal roots, and seriously retards the growth of the plant. I have heard of a case in the far North of Queensland where 4 acres of young plants were absolutely destroyed by swamp couch. If, however, the couch, if it be present, is well kept down during the hot summer months it will not cause much trouble afterwards.

The sisal plant requires all possible light, air, and sun. Therefore, no weeds may be allowed to overtop it. Tall weeds may be mown down. It is not absolutely necessary to clean the field when the weeds are below the plants, as such weeds do little or no harm. Any brushwood or shrubs should, of course, be cut down before they top the plants.

In about twelve months the suckers will begin to appear, and in twenty-four months they will be produced at the rate of over 100 per plant. These suckers must be removed for two reasons. One is, that they

deprive the mother plant of the nutriment it requires to produce large leaves and plentiful fibre. The other is, that the suckers are valuable either for extending the area under sisal, or for sale to intending planters. Should they not be required for either of these purposes, still they must be removed, and can be destroyed. For a long time to come, however, planters who now have suckers will be able to dispose of large quantities at remunerative prices. To plant up 100 acres, from 60,000 to 100,000 suckers are needed. It will, I trust, not be long before we shall see 10,000 acres and more under sisal cultivation in Queensland, especially as the Federal Government now grants a bounty of 10 per cent. on the value of the fibre produced up to £6,000 in a year for nine years. That means that there will be a demand for some 10,000,000 suckers. Already there is a demand for almost as many as any present plantation can supply. Importations from foreign countries are impossible in some cases, owing to the prohibition against their export. In other sisal-growing countries there is a heavy export duty, in addition to the original cost of the plants, as well as the expense of cartage, bags, freight, and commission, both in the exporting country and in Queensland.¹ A Hawaiian agent offered me 1,000,000 plants at prices ranging from £2 10s. for bulbils to £5 per 1,000 for plants 12 in. high. This was f.o.b. at Honolulu, and all other expenses, besides the great loss bound to occur from sweating in a steamer's hold, would have to be added. Mr. Consul Leay, whose report on Vera Cruz for 1903 I have already quoted, says: "The purchaser, if wishing these (the plants) for use outside the State (of Yucatan), would have to pay about 80 dollars (Mexican) (£8) per 1,000, in

¹ The German Government, in German East Africa, imposed an export duty of £7 10s. per 1,000 plants in 1908.

addition to the cost of cutting and other charges, as well as a heavy export duty. And purchasers have been known to wonder why they would not grow, not being aware that the grower has been known to *boil the shoots* to prevent competition in other lands." Mr. Leay concludes his report by stating that "the growers have all become enormously wealthy, many of them being millionaires," and that, "roughly speaking, what costs 1 dollar to produce sells for 4 dollars."

POLING AND LIFE OF THE PLANT.

The life of the sisal plant is intimately connected with the production of the flower stalk, technically called the "pole." The life of the agave is a comparatively long one, but this long life may be materially shortened by careless or injudicious management. The sign of the termination of its existence is when it sends up a pole from the centre. This happens when the plant arrives at the cutting age, and the leaves are not cut. It may also be the result of over-cutting. Much judgment is therefore required to ensure that no pole shall appear for ten, twelve, fifteen, or twenty years.

In a complete account of the sisal industry in the Bahamas, prepared by Sir (then Dr.) Daniel Morris, published in one of the "Colonial Reports" series (Miscellaneous, No. 5, 1896), we read: "A question arose in 1893 as to the early 'poling' of sisal plants in the Bahamas. It was feared that if they began to pole at five to seven years there was little time in which to obtain a succession of leaves to carry on the industry. The aid of Kew was called in to answer the question, 'How long would the plant be available to the planter for production of fibre?' The matter was one of the greatest interest to the Bahama people, for on it depended the success of their plantations."

This is a matter of no less importance to Queensland planters, and fortunately the result of the inquiry showed that there need be no greater anxiety felt in the Bahamas on this point than had been felt during thirty years in Yucatan, for plants that had poled might be easily replaced from time to time by strong healthy "supplies" from nurseries, and the work of the plantations need not at any time be interrupted. Mr. Pearce stated that "hemp plantations in Yucatan lasted for some fifteen years." This was not conclusive as regards the age of individual plants. It merely showed that, while some of the original plants poled at one age and some at another, their places were so filled up from time to time by new plants that the whole undertaking received no serious check up to about the fifteenth year. "It is believed," says Sir Daniel Morris, in the paper I am quoting from, "that if the root suckers are allowed to remain attached for a long period, they tend to exhaust the parent plant and accelerate the period of poling. Such suckers diverted the strength of the parent plant, and, if allowed to remain too long, either of two things must happen—the parent plant would produce fewer and smaller leaves, or its period of maturity would be hastened. The practical outcome of this was the suggestion that such suckers as were necessary for supplying the plantation should be taken, when large enough, into nurseries, and all others be removed regularly and thrown away. . . . The result of further experience has shown that some plants pole at five or seven years; others at a later period. It was improbable, if properly treated, that they would all pole, over a large plantation, at the same time. If the plantation were carefully watched, and fresh plants put in as soon as the older plants reached maturity, there would be little interference with the work of the plantation. It was further considered as essential

that fresh plants, in large numbers, should be grown in nurseries, with the view of supplying vacancies caused by poling. Also, that the pole should be cut, or, better, notched and bent over, as soon as it appeared, in order that all the leaves on the plant should be ripened before it died. In this way the plant would be kept available for yielding fibre for nearly a year later than it otherwise would be. Another point was insisted upon, and it is this point which demands the careful attention of all planters in Queensland. It is one which I have noticed has not received attention in this State where the plant has already been cut for fibre.

The point is, that while all the mature leaves should be cut when they had attained full development, great care was to be taken that

IMMATURE LEAVES SHOULD NOT BE CUT.

“The regular cutting of the fully-matured leaves was understood by some to prolong the vegetation life of the plant, and retard poling. Theoretically, however, there is no ground for such a supposition. On the other hand, the cutting of immature leaves would certainly have a contrary effect. The plant would be likely to be weakened by the process, and the subsequent leaves borne by it would be fewer and smaller.

THE EXACT PERIOD WHEN LEAVES SHOULD BE CUT requires careful attention. As a general rule, the leaves are ripening when they are gradually falling from the erect to the horizontal position on the plant. There are also some indications of change of colour of the leaves.

“It is somewhat of a coincidence that exactly similar questions arose in Mauritius when the hemp industry was started there some twenty years ago. [Sir Daniel Morris wrote this in 1896 ; therefore the

period when the industry was started there is now thirty-six years behind us.] The plant cultivated in the island is the green aloe (*Furcraea gigantea*). It is similar to the sisal hemp plant in appearance and habit; it also produces bulbils or pole plants after flowering, but the flowering branchlets droop gracefully instead of standing out rigidly, as in the sisal plant pole.

"M. de Chazal stated that the plants generally poled there at the age of 7 or 8 years, but they could be cut four or five times before poling, and therefore before it was necessary to replace them. Another account mentioned that many of the aloes flowered three or four years earlier than others; hence the leaves of the seedlings of the former were fit for cutting when the late-flowering plants were dying out; so that cutting, once begun, was practically continuous. Supplying amongst old plants was done in time, so that as the old ones died out cutting from the young ones was ready to begin. Over-cutting in Mauritius was held to be injurious to the plants, weakening their growth and causing them to flower and die prematurely. In Mauritius also it was found that, by cutting only the matured leaves, the growth of the plant was not weakened. Thus, large, fine leaves were obtained, yielding long fibre of the finest quality.

"There is another important factor, apparently overlooked, in regard to the poling of sisal hemp plants in the Bahamas. In Yucatan the plantations are established for the most part with suckers, not pole plants. The latter are not so often available, for the pole is removed as soon as it appears. Owing to the heavy demand which existed a few years ago in the Bahamas, pole plants were very largely used. In fact, in many places they were the only plants used. Added to this, they were mostly small in size, and conveyed in large quantities in the holds of schooners,

where they got overheated and weakened. Such plants were necessarily predisposed to early maturity. I am also of opinion that pole plants, produced as an expiring effort of the parent plant, are not always calculated to produce such robust plants as suckers; at least, they are not likely to be so when derived from plants whose leaves are periodically reduced when cut for fibre purposes."

I have quoted thus largely from Sir Daniel Morris's paper, because whatever emanates from so eminent an authority on tropical agriculture can be accepted without the slightest hesitancy, and, when dealing with the extraction of the fibre and machinery, I shall again avail myself of his experience in these matters.

There is one thing I have noticed in our small Queensland plantations which deserves attention. When a mature plant, surrounded by suckers, sends up its pole, the older suckers at once follow suit, and send up slender poles which will produce a small number of flowers and bulbils. From this it results that care is needed in taking up suckers for making fresh plantations or for supply. Suckers should not be taken from a poled plant, for when the former are planted out it will not be long, possibly not six months, before the pole appears. The leaves of such plants are, of course, small, few in number, and quite valueless for machining, consequently they must be removed and fresh plants put in their place, which entails a loss of twelve months' growth.

LOSS OF LEAVES BY POLING.

Some photographs by Mr. W. H. Mobsby, photographer to the Department of Agriculture and Stock, in the Brisbane Botanic Gardens, clearly show the loss of leaves which ensues upon the poling of the sisal hemp or *furcræa* plant. At the time of sending up

the flower pole there are about 210 leaves still uncut on the plant. If the central bud, which develops into the flower pole, be cut shortly after its appearance, these leaves will be saved, and the plant gains a year longer of life. The tough and leathery leaves to be seen drooping to the ground cannot be successfully machined for fibre. Two hundred 4-lb. leaves, such as are produced in the State, yield about 300 oz., or, say, 20 lb. weight of fibre. The advantage of cutting off the flower stalk, except in cases where plants are required, is therefore obvious.

The pole on which the flowers and seeds are borne runs up to a height of from 15 to 30 or even 40 feet. On this pole a number of minute green blossoms are borne. These, in time, develop small bulbs called "bulbils," which ripen and fall to the ground. In many instances 2,000, or even 3,000, new plants are thus produced on one furcræa, and from 700 to 1,000 on a sisal pole. They frequently, it may be said usually, remain on the branchlets until they have not only developed three or four leaves but even small rootlets, so that when these fall they are ready at once to plant in the nursery. In the case of undeveloped bulbils being required for the nursery, they should not be planted like ordinary bulbs, but laid on the surface of the soil, when they will send down their roots and soon stand erect as plants. If they are not needed for the nursery, they can easily be raked together and destroyed.

HARVESTING AND YIELDS.

According to conditions of climate, soil, and the kind of plant, whether produced from suckers or bulbils, the first leaves will mature in from three to four years. In the southern districts of Queensland, and on poor forest soil, a first crop will be produced in five years.

For the harvesting of the leaves, account must be taken of their length and state of ripeness.

The length of the fibre is one important factor in its fitness for the market. The least length admissible is 2 ft. 6 in., and every additional length increases its value. It is not advisable to cut leaves until they have attained a length of at least 3 ft. These lengths were lately given to me by the Belfast Ropeworks Company, Ireland, and the Mannheim-Neckerau Rope-making Company, Germany. I have seen, on one plantation in Southern Queensland, leaves nearly 3 ft. long on two-year-old plants, but this is exceptional, and cannot be considered as a general rule. Leaves of the *Agave rigida* var. *sisalana* generally average in Queensland a weight of 3 lb. each.

In 10 tons of *Furcraea gigantea* leaves, grown in the Brisbane Botanic Gardens, and treated at St. Helena in May, 1906, the average weight of the leaves was 5 lb., some attaining a weight of 7 lb., and the length, which averaged 6 ft., reached in many instances from 7 to 9 ft. With respect to the ripeness of the leaves, this is shown in two ways: First, by the position of the leaf in relation to the trunk. Whilst growing, the leaf is at first upright, rising from the centre of the trunk. As it ages, it gradually inclines downwards, till it stands out rigidly at right angles to the trunk. This position indicates that it is ripe, and should be at once cut. If left very long after this position is reached, the leaf bends and droops to the ground. It does not follow, however, that such over-ripe leaves are valueless, for I have seen first-class fibre manufactured from them, even after the plants had poled. Generally speaking, however, the fibre of such leaves is somewhat spotted, and a considerable amount is wasted by being broken off short in the machine. Over-ripe leaves will make more waste or "tow" than those which have just reached maturity.

The unripe leaves, and especially the young central leaves, produce a brilliantly white fibre, but far less in quantity, and, as I have already shown, the cutting of these unripe leaves is a serious mistake, as it causes the plant to pole prematurely.

Again, the ripeness may be known by a change of colour in the leaf, which is naturally of a light-green, at least in the Sacqui variety. When the leaf of this variety changes to a dark-green it has reached maturity, and the change of colour will invariably be observed when the leaf has reached the ripe position above described.

It must be understood that, from its very infancy the leaf contains a quantity of fibre, and were it not that length is required, harvesting might begin within twelve or eighteen months of planting.

When from three to four years old there will be a number of ripe leaves on each plant, which number will vary according to conditions of planting from 10 to 20 for the year per plant. In subsequent years the number may rise to 40 or 50. This does not mean that 40 or 50 leaves are at once cut from each plant, but that a plant will admit of cutting that number of leaves as an aggregate of the year's operations. In the case of poled plants, I have seen 200 leaves taken off at once, but then that plant's life was ended.

The leaves are cut off with a curved knife about the size of a butcher's knife, but with a longer handle, to allow the cutter to reach the trunk. If the knife is kept perfectly sharp, the leaf is easily severed.

Proper cutting consists in cutting the leaves as close as possible to the trunk. Shaving the latter will express what is meant. If 2 or 3 in., or even 1 in., is left behind, there is a great loss. I will hereafter show what the loss of fibre is by loose cutting. Furthermore, the vigour of the plant is injured when

the leaf is cut at any distance away from the trunk. It will be understood that the lower leaves must be cut first to enable best results to be arrived at, and to prevent damage to the upper leaves. I have seen a man cut upper leaves in half to make his work more easy to himself. Needless to say that this is criminal waste. As the leaves are cut, they are tied up in bundles of 50 to facilitate counting, where men are paid by the 1,000 leaves. With our heavy leaves 50 is a big load for a man to carry to the roadway, but a less number would entail too much loss of time to the workmen. If the prickly variety is being harvested, the prickles must be lightly sliced off the edges, saving as much of the fibrous part as possible. The thorn at the point must also be removed. Where the planting has been done at wide intervals, the bundles may be removed on a low trolley or sledge to save carrying them to the roadway, but this would be impracticable where the plants are only 8 ft. apart, as the horse and the conveyance would damage the growing leaves in their passage. The cutting of the leaves should be constantly inspected, as the cutters, for their own convenience, are apt to cut immature leaves, and also to cut not close to the trunk.

One man should cut and tie up 1,200 leaves on an average daily, but expert cutters at Childers (Queensland) have cut as many as 2,500 leaves daily. A good cutter at St. Helena averaged this, besides removing masses of suckers at the foot of the plant which impeded his work; the leaves, however, were not tied up, but thrown loose into a dray.

YIELD.

Now as to the yield of fibre. Some people hold exaggerated ideas of the yield from a sisal plantation. These ideas have been based on some exceptional

returns which are authentic, but which only occur under exceptionally favourable conditions, and are very few and far between. For instance, it is on record that a two-year-old plantation in Yucatan yielded $1\frac{1}{2}$ ton of fibre per acre. But it does not follow, therefore, that cutting may be begun in two years, and that such a remarkable result must follow. Far better to set down the maximum cost of production and the minima of yield and profit.

In No. 4 Bulletin of the Hawaii Agricultural Station, Mr. Frank E. Conter gives the palm for yield of fibre to plants grown on porous coral rock. He says: The first cutting averages 25 leaves per plant. The yield of fibre varies. In the case of planting 7 ft. by 7 ft. (889 to the acre) on the poorest soil, without cultivation, a total of 4 lb. 12 oz. per plant, or $4,264\frac{1}{2}$ lb. per acre, was obtained. On poor average soils, planted 7 ft. by 8 ft. (799 to the acre), 7 lb. of fibre per plant, or 5,630 lb. per acre, is obtainable. Porous coral rock, with only a trace of soils, planted 8 ft. by 8 ft. (680 plants to the acre), gave 10 lb. 6 oz. per plant, or 7,055 lb. to the acre, whilst porous coral rock, with a larger mixture of soil planted 8 ft. by 9 ft., on account of the larger size of the leaves, yielded 8,500 lb. of marketable fibre to the acre.

Allowing 1,000 plants to the acre, each plant at four years gives 40 leaves a year, of a weight of about 120 lb. This has been shown to be the average weight of leaves in Queensland. In Yucatan, the weight averages about 1 lb. 10 oz. Let us take a lesser weight as a basis for a calculation of returns—that is, 50 lb. as the weight of 40 leaves. Four per cent. of this turns into marketable fibre, dried and white, or 2 lb. of fibre per plant. This gives us 2,000 lb. to an acre. The value of the fibre in the Melbourne market is at present (1908) £27 10s.

per ton, f.o.b. at Brisbane. We will, however, take £35 as the market price. An allowance for cultivation, preparation, baling and carriage to a Queensland port of 40 per cent. on the value of the fibre is considerably in excess of the truth—40 per cent. on £35 is £14. Deducting this from the sale price, the net proceeds per acre amount to £21. The planter will, however, do well to reckon for a first crop upon about $\frac{1}{2}$ ton of fibre per acre; 40 per cent. on the sale price, £17 10s., reduces this to £10 10s., which represents the net profit per acre.¹

To come to what has been actually done in Queensland. Sisal hemp was planted, as I have shown, at the penal establishment at St. Helena, where it was closely planted on the windward side of the island to act as a windbreak for the preservation of other crops. As there was, at the time of planting, no intention of extracting the fibre, the plants were put in thickly, in a long treble line, covering a little less than an acre. These plants grew luxuriantly for five or six years, and formed an impenetrable hedge. When the sisal hemp industry began to attract attention in Queensland, about the year 1902 or 1903, the demand for plants was supplied from St. Helena, until up to the present time of writing some 300,000 plants had been distributed to intending planters. It was then thought by the Minister for Agriculture that it would be advisable to make an experiment with the older plants to test their fibre-producing qualities. A machine, the Lehmann Raspador, was consequently obtained from England, and the work of extracting the fibre from the matured leaves was begun. It soon became apparent that these contained considerably

¹ From 3½-year old plants on Mr. T. H. Wells' plantation at Childers, near Bundaberg, 1½ tons of commercial fibre were obtained per acre at the first cutting but such records are too high to be considered commercially.—H. H. S.

more fibre than is usually extracted in Yucatan or the Bahamas. Accurate note was made of the weight, number, and quality of the leaves. The fibre from those of the plants which had already poled was kept separate from the rest. Fibre only slightly damaged was not mixed with the perfect product, and great interest was taken by the officials in charge of the operations. The result was that a splendid sample of long, brilliantly white fibre was produced. A second machine, the Death and Ellwood, was obtained from a private owner in the State, and both machines were simultaneously worked by a $6\frac{1}{2}$ h.p. oil engine. As the workmen gained experience in cutting and driving the machines the daily output increased in a remarkable degree. A single cutter was able to cut 1,200 leaves in a day of eight hours, in addition to removing the numerous suckers. When the first cutting was completed the whole area was worked over a second time, all mature leaves being removed, as well as the whole of the leaves of the poled plants, which numbered 200, giving from 100 to 200 leaves each. Eight hundred and ten plants which had not poled were also dealt with. Thus, the total number of plants cut amounted to 1,010, equal to about one acre had they been planted 6 ft. apart in five rows at 36 ft.—that is to say, 4 at 6 ft. distance and 1 at 12.

The total yield of marketable fibre from this plot amounted to 2 tons 1 cwt. 22 lb. Of this quantity 6 cwt. was made into rope, binder twine, clothes lines, halters, &c., and the balance was sold at £35 and £37 10s. per ton in Melbourne. Here we have an officially authenticated yield of over 2 tons of marketable fibre from one acre of sisal plants, averaging £36 5s. per ton, besides which there is a considerable quantity of tow fit for rope-making or other purposes. The gross proceeds, exclusive of, say, £5 worth of tow, amounted to over £73. Taking off 80 per cent.,

which is double the usual allowance, for expenses, wear and tear of machinery, cartage, &c., the net return would amount to over £15 per acre, in addition to the value of the tow. There was no labour expended on this plot from the day the plants were put in until the crop was harvested. The plants were exposed to heavy south-easterly gales and to occasional hailstorms, yet they survived all, and yielded the return as above. It should also not be forgotten that 350,000 suckers have been sold off the same acre lately, and 50,000 more were supplied to a planter near Cairns.

I will now take another case—one in which the plants are regularly planted at a distance of 8 ft. every way. This gives 680 plants per acre, and we will allow 3 lb. as the average weight of leaf. The first cutting after about four years will give 25 leaves per plant, equal to 75 lb. of green weight, yielding $36\frac{1}{8}$ oz. of fibre, or about $3\frac{1}{3}$ per cent. Within four and a half years an additional 150 leaves per plant will mature, giving 450 lb. of green weight, yielding $13\frac{1}{2}$ lb. of fibre, or nearly 4 per cent. The remaining 60 leaves, maturing after cutting the pole, will vary in weight and yield of fibre, but will yield, say, about 3 lb. of fibre.

This makes a total weight of $18\frac{1}{2}$ lb. of fibre per plant, or, for the 680 plants, 12,580 lb. per acre in five and a half years, equal to 2,287 lb. 4 oz. per acre per annum.

The money value of this is	...	£35	14	8
Deduct for expenses 50 per cent.		17	17	4

Net profit ... £17 17 4 per acre.

It must be borne in mind that these results have been accurately calculated to an ounce by expert growers. Where the needed plant food is plentiful, the usual crop of fibre amounts to about £25 per

acre in five years after planting, or, less expenses, £12 10s. per acre. Sir Daniel Morris said that the yield in the Bahamas is much higher, the fibre constituting 5 per cent. of the weight of leaves. The average weight of the Mexican leaf is 1 lb. 10 oz. ; of the Bahama leaf, $2\frac{1}{4}$ lb. ; and of the Queensland leaf, 3 to 4 lb.

The first balance sheet of the Hawaiian Fibre Company, published in 1903, showed that notwithstanding the great initial expenses of starting the plantation, high salaries, erection of buildings, purchase of the best machinery, &c., the return from a first crop from 120 acres was £1,600, or £13 6s. per acre. If we deduct 40 per cent. for expenses and labour, the net profit was £8 per acre. Succeeding years were more and more profitable.

Taking all factors on which the yield of fibre depends, the planter will, as a general rule, make a clear profit of from £8 to £10 per acre, and frequently considerably more.

SHORT DIRECTIONS FOR PLANTING AND FIBRE EXTRACTION.

(1) Lay out the ground with a 12-ft. roadway between every eight rows.

(2) Put in the plants in holes 8 ft. apart every way.

(3) Plant them perfectly upright.

(4) There is no need to plough up the whole ground. When any tall grass or bushes grow between the rows, cut them down every three or four months. The plants must have no shade.

(5) Plants produce better fibre in unploughed than in ploughed ground.

(6) Take off any dead leaves from the plants before putting in. Treat them like pineapple plants,

and cut off all old roots ; by so doing the plants quickly send out new roots, and start growing at once.

(7) When planting, allow no soil to fall between the leaves, or the plant will rot.

(8) In very dry weather give each plant, when planting out, a pint of water. They will take root in a week, and after that will defy dry weather.

(9) Suckers and bulbils may be put out in a nursery until they are about 8 in. high, when they are at their best for planting out.

(10) Do not plant in low or wet ground. Dry ridges suit the plants best.

(11) When plants are three years old, a first crop of eight or ten leaves per plant may be cut. In four years a full crop of twenty leaves may be cut, but this only refers to tropical Queensland. In the South a first crop cannot be obtained under from four to five years.

(12) The yield of fibre is 4 per cent. of the weight of leaf. A 4-lb. leaf will give $1\frac{1}{2}$ to $1\frac{3}{4}$ oz. fibre.

(13) If the leaves are regularly cut, the plants will not send up a pole for from ten to fifteen years. When a plant poles, the 200 leaves still left will be lost. But if the pole, at its first appearance, is cut, the plant will live twelve months longer, and all the leaves will be saved.

(14) Cut away all suckers, and, if no ground is ready for them, put them in a nursery for future planting.

(15) Leaves are ready for cutting when they droop from a perpendicular to a horizontal position.

(16) There is no regular season for planting or harvesting. Both operations may be carried out at any time of the year, but September is the best month for planting.

(17) A machine for scutching costs about £35 in Europe or Mexico. Hand machines are unworkable,

as a high speed (400 revolutions a minute) is required. Use a horse gear or oil engine.

(18) With a good machine (the Barraclough-Lehmann, Death and Ellwood, Todd, Prieto, or Finnigan-Zabriskie) from 8,000 to 150,000 green leaves can be passed through the drum in ten hours.

(19) About 100 gallons of water are used daily to wash the fibre as it passes through the smaller machines, and about 1,000 gallons with the largest. When the fibre comes out it is hung upon wire lines in the sun for a few hours, and after a day or two in the shed it is then ready for baling and sending to market.

(20) The cost of production is about 1d. per lb. of fibre. Generally speaking, the whole cost, from cutting to market, is about 40 per cent. of the value of the fibre—that is to say, if you sell fibre at the usual market value—£35 per ton—the cost of production will be £14, and the balance profit.¹

(21) The average annual return of fibre is about 10 cwt. per acre for the first year or two, and after that as much as 1 ton. In Yucatan 1½ ton of fibre was produced from two-year-old plants, but this was exceptional, and cannot at all be reckoned on, although at St. Helena Penal Settlement 2½ tons were obtained from an acre.²

(22) Melbourne will take 2,000 tons of fibre per annum, and there is a never-failing market in Sydney, New York, as well as in Germany, France, Ireland, Scotland, and England.

¹ It should be understood that the price of sisal fibre fluctuates in response to the price of Manila hemp. For instance, in 1907, Queensland sisal fibre sold at £36 10s. f.o.b. Brisbane. In 1908, the price fell to £24 per ton in August, corresponding to a fall in the price of Manila, whilst in February it realized £30 per ton net.

² The above of course refers to 1910 and before that. Compare the above figures and those elsewhere with what is said in the latter section of the book to do with preparation.

THE ENEMIES OF THE SISAL PLANT.

For 800 years the sisal plant has been remarkably free from any disease, but lately, in the Bahamas, a fungoid growth has been found, which was described in 1903 by Lyster H. Dewey, Botanist in Charge of Fibre Plants, United States Department of Agriculture. Yellowish spots were observed on the leaves. These spread; then the leaf curled and dried up. In a week or two it was black and hard. Mr. Dewey suggested that any plants found to be attacked should be grubbed out and destroyed. In 1905 these yellow spots were observed on plants at St. Helena and Peel Island. The leaves were submitted to Mr. H. Tryon, Government Entomologist, who emphatically declared that the spots were neither the result of fungoid nor of insect attack, and that the discolouration would disappear in due course. This actually was the result, and no disease has appeared amongst the sisal plants in the State. The yellow patches were proved to be the effect of hot sun on distended water cells in the plants. In the Bahamas, a mealy bug (*Dactylopius* sp.) was discovered preying on the leaves, but it was easily kept in check. In Queensland, however, this insect has not appeared. In Mexico the locust is troublesome, but the insect does not affect the plant in Queensland. The agave is not a deep-rooting plant, therefore its worst enemy is a hurricane. A strong gale of wind will uproot a large number of plants in an exposed position unless planted thickly together. This actually happened in a plantation in the North of Queensland, where numbers of plants were blown out of the ground. Fire and frost are not so much to be dreaded by the sisal planter as undrained land. In 1905, terrible bush fires swept over many parts of Southern Queensland. My sisal plantation was swept almost from end to end by a fierce

fire carried by a strong gale. Fences, houses, and stables were destroyed in spite of all attempts to save them. Yet the sisal plants survived, and the most healthy-looking plants are those which stood at the rear of and within 10 ft. of the burning stables. During the winter of that year, the thermometer repeatedly stood at 26 and 28° F., yet no injury was done to the leaves. Several varieties of agave and *furcræa* may be seen growing on the Darling Downs, where the frosts are very severe, and where, in recent years, heavy falls of snow occurred. On the other hand, where small plantations have been exposed to the wintry westerly winds, the plants have been killed, or, rather, the leaves have been killed, the roots sending up fresh shoots in spring. This occurred at Biggenden State Farm in the Burnett district, and on Brown's Plains in the Logan district; yet, during the heavy and continuous frosts in July and August of 1908, sisal plants on the Darling Downs at Westbrook State Farm were untouched, although 20° of frost were registered night after night. On the other hand, in Central Queensland, on the Government plantation at Bajool, near Rockhampton, half the plants were seriously damaged by frost, the reason for this anomaly being that the plants, never having experienced hard frosts before, were too tender to withstand such abnormal cold. It is decidedly a mistake to plant sisal where there is danger from frost, or where stagnant water lies, notwithstanding the incredible vitality of the plant.

CONSUMPTION AND PRICES OF SISAL
FIBRE 1894 to 1909.

FLUCTUATION IN PRICES.

During the sixteen years, between 1894 and 1909, the following quantities and values of the importations

of sisal into the United States will show the magnitude of the industry :—

Year		Tons		Average price per ton				Market prices for best samples		
				£	s.	d.		£	s.	d.
1894	...	48,468	...	15	9	2	...	—		
1895	...	47,596	...	11	19	11	...	—		
1896	...	52,130	...	13	1	11	...	—		
1897	...	63,266	...	12	2	6	..	16	6	8
1898	...	69,322	...	14	2	5	...	27	18	4
1899	...	71,898	...	25	13	0	...	34	4	2
1900	...	76,921	...	30	13	2	...	35	8	4
1901	...	70,076	...	22	16	8	...	32	11	8
1902	...	89,583	...	26	16	8	...	43	1	8
1903	...	87,025	...	30	11	3	...	36	6	8
1904	...	109,214	...	30	7	9	...	40	6	8
1905	...	200,000	...	35	0	0	...	35	0	0
1906	...	94,507	...	36	0	0	...	40	0	0
1907	...	92,621	...	37	0	0	...	39	0	0
1908	...	104,000	...	25	14	2	...	27	0	0
1909	...	88,577	...	27	8	9	...	29	10	0

From January 1 to March 15, 1910, the United States imported 87,888 bales, the spot quotation being £29 per ton.

The exports of fibre from Yucatan in 1903 amounted to 590,430 bales, of a value of £3,333,114; and, in 1907, 611,845 bales, of a value of £3,772,938.¹ In addition to this, Mexico exported binder twine to the value of £92,595.

In 1904, a sale was effected in New York at £40 6s. 8d. per ton.

In 1906, a Mexican consignment to New York was withdrawn from sale, £39 13s. 4d. per ton being refused.

During the sixteen years cited it will be seen that the importations have not only nearly doubled, but the price obtained per ton has, during the same time, increased proportionately, making the value for 1903 approximately five times as much as that for 1894.

During 1905 and 1906 the price per ton still

¹ About 6 bales make 1 English ton.

further advanced, ranging from £35 to £37 10s. per ton, whilst production could not keep pace with the demand. The reduction of the output of Manila hemp, which latter article usually regulates the hemp market, had a still further effect in raising the price of sisal, whilst the expansion of the wheat-growing industry in the United States, Canada, Australasia, and other colonies indicates a still greater demand for binder twine and a corresponding increase in price.

THE FLUCTUATIONS IN SISAL HEMP PRICES DURING
TWENTY-FIVE YEARS

are clearly shown in the following diagram which appeared in the *West Indian Bulletin*.

The *Journal d'Agriculture Tropicale*, Paris, in its issue of January, 1905, published the diagram in the following interesting article which I think it well to insert here:—

“The diagram on which this article is merely a commentary is borrowed from a recent number of the *West Indian Bulletin*, the excellent quarterly journal of the Department of Agriculture of the British Antilles. That department is interesting itself in the development, in all suitable localities, of the cultivation of sisal hemp, which industry is already firmly established in the Bahamas, and in a less degree in the Turk's Island and the Caicos Archipelago. As it is, on various occasions large quantities of sisal plants have been introduced into Jamaica and Trinidad, but the experiments appear to have been carried out in a half-hearted manner in those islands. It is probable that further experiments will be made under more favourable conditions. Meanwhile, the Department has just published an excellent bulletin of about twenty pages on this subject. The author of this bulletin has rightly given a relatively important

place to the consideration of markets and prices, and we think it will be of interest to reprint that portion of the article in question, especially as we are in a position to furnish later information gathered from other sources.

"In 1888 and 1889, owing to the formation of the National Cordage Trust in the United States, and the efforts made to control the entire supply of white-

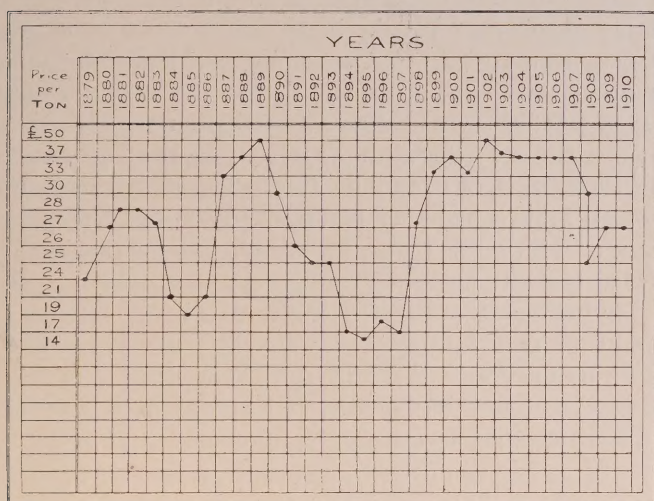


FIG. 4.—Diagram representing fluctuation of sisal prices.

rope fibres, the price of sisal was extraordinarily high. This was a purely artificial state of things, and had no reference to the ordinary market value of the fibre. The average price in 1877 was £33 per ton. In the beginning of 1888 it rose to £36 10s., but towards its close, owing to the action of the Cordage Trust, it went up to £45 per ton. In January, 1889, it reached £50 per ton. This was unprecedented; but in March of that year it went higher still, and reached a maximum of £56 10s. per ton. At this price two

bales of Bahamas sisal happened to be sold in the London market. This circumstance really did harm to the prospects of the industry, as it stimulated over-production in Yucatan. The two bales in question were bought at this fancy price for a special purpose—viz., for making ladies' hats and bonnets. The consumption for this is so trivial as to be hardly worthy of notice. Soon afterwards the Cordage Trust came to grief, causing serious loss, if not ruin, to a large number of people in the States. The large stock of fibre held by it coming suddenly on the market, prices fell so rapidly that at the end of 1890 good fair fibre was sold at £27 10s. per ton. In 1891 it was further reduced to £23 10s.; in 1893, to £20; in 1894, to £15; until in July, 1895, it reached the lowest price it had ever reached. This was £13 per ton, or a little less than 1½d. per lb. Since that time it has improved.

“In 1896 it was quoted at £17 to £17 10s. per ton, and from that date the price steadily rose, as will be seen by the diagram, till, in 1902, it reached £37 per ton. In 1905 it was quoted variously at from £33 to £35 to £38 per ton, according to quality.”

In 1906 sisal fibre was sold at £37, and this price was fairly well maintained until 1908, when the price fell, in March of that year, to £30, and in June to £25. The reason for this sudden fall is to be found in the position of the Manila hemp market. In May, 1908, fair Manila brought £26 per ton for June-August shipment. At this price it became apparent that a good deal of hemp would be for sale, and buyers speedily withdrew. American buyers would not make the smallest advance. The real cause of the apathy amongst manufacturers was the abnormally bad state of trade in connection with both railways and shipping, which had a material effect on the demand for cordage. Again the market was held

"artificially," quite a large quantity of hemp having been bought for a rise, and eventually was resold. Combined with this, there were various unsold dealers' stocks due to arrive in England during August and September, which might at any moment have to be liquidated. Hence the price of "Fair Current" fell to £24 per ton in April and May. As Manila hemp rules fibre transactions, the market for sisal fibre suffers for the time being until stocks are depleted, when a rise must again take place. In October, 1908, sales of Bahama fibre were effected at £32 per ton. During 1909 the price of "Fair Current" fluctuated very much, falling in May to £19 15s. Values then gradually rose until in December "Fair" was worth £27. Statistics given in Landauer and Co.'s London report to May, 1910, show that the price for Furcræa (Mauritius hemp) is about the same as for sisal—£27 per ton.

SOME OTHER HEMPS.

FURCRÆA GIGANTEA (MAURITIUS HEMP).

This fibre plant is somewhat similar in appearance to the sisal agave, having the same habit of growth, and producing suckers, flower poles, and bulbils in the same manner as the *Agave rigida*. It is, nevertheless, not an aloe, although it belongs to the same natural order as the agave—viz., Amaryllidaceæ. It is found in many parts of Queensland, and wherever it has been introduced it has thriven as well as in its native Yucatan and Mauritius. The leaves grow to a length of from 6 to 9 ft., and produce a large amount of fibre, which, although it is not so valuable as sisal fibre, has a considerable commercial value. Some of the Furcræa may be recognized by the unpleasant smell noticeable when a leaf is scratched, hence it obtained its first botanical name, *Furcræa fœtida*. It is also dis-

tinguishable from the *Agave rigida* by its light colour, occasionally variegated, as in *F. Lindenii*, and by a longitudinal depression on each side of the central ridge of the leaf. It is the plant producing the Mauritius hemp of commerce. The following interesting account of the Furcræa and the aloe industry of the Mauritius is taken from the annual report of Mr. P. Boname, Director of the Agronomic Station at Mauritius, extracts from which report were published in the *Journal d'Agriculture Tropicale* :—

In Mauritius the *Furcræa gigantea* is exclusively employed for the production of fibre, and on this point the editor remarks : “The fact of the economic superiority of the sisal (*Agave rigida*, var. *sisalana*) over the Furcræa, which may be considered to have been clearly proved by Mr. Boname, is borne out by all that has been published up to the present about the vast plantations, as yet young, in German East Africa. The Germans have already lost much money by ignoring this superiority when forming their plantations, and they will lose still more.”¹

The textile fibre industry has assumed fresh importance at Mauritius, owing to the increase in price of these products during the last few years.

There, the *Furcræa gigantea*, vulgarly called “green aloe”—to distinguish it from the *Agave americana*, or blue aloe, of which there are a few isolated plants in the Furcræa lands—is exclusively worked. As a matter of fact, the Furcræa is not *cultivated*, it is simply harvested—that is to say, new plantations are rarely formed; the planters content themselves with gathering the leaves of existing plants, which have rapidly increased on the dry barren shores where want of water will not admit of any other crop being raised.

¹ The true sisal has since been planted in the German colony.—A. J. B.

When the *Furcræa* flowers, its flower pole supplies a large number of bulbils, which ensure a natural reproduction. These bulbils fall on to a soil more or less cumbered with an herbaceous or shrubby vegetation, and easily take root. In the early days of rooting, they form a thick nursery of young plants, but gradually the greater number die off and disappear, and only the strongest or those growing under the most favourable conditions survive. Barely sufficient live to ensure a prolific propagation of the species.

The lands on which the *Furcræa* has increased are generally covered with a vegetation consisting principally of "Old Maids" (*Lantana camara*) and of Acacias (*Leucæna glauca*). These three dispute the empire of the soil, so that it is impossible to arrive at an estimate of the return which might result from a plantation properly formed, with the plants placed at regular distances so as not to be destructive of each other.

One of the advantages of the fibre industry is that the crop may be gathered whenever the farmer pleases, either when market prices are at their best, or when local circumstances such as supply of labour or other matters are most favourable. In fact, the harvest can wait without any danger of deterioration. Thus many sugar-planters who have large areas of land uncultivated and covered with *Furcræa*, manufacture the fibre during the slack time, when labour is abundant and cheap. If the price for the fibre falls, or if labour is scarce, the manufacture of fibre is stopped, to be taken up again with renewed activity when conditions are more favourable.

The export of *Furcræa* fibre from Mauritius has varied during the last twenty years from 358 to 3,000 tons annually, the value being from 90,000 to 1,000,000 rupees, or from £6,000 to £66,666.

The average price paid locally during the same

period has varied from an annual average of from 207 to 420 rupees (£13 16s. to £28) per ton. It will be seen by these differences in output and value how advantageous it is to be able to push on manufacture at certain times, seeing that the price given at first scarcely varies at such seasons.

When the factories are in want of leaves they buy them wherever they can find any for sale. The cost of leaves sufficient to make 1 ton of fibre averages about 10 rupees (13s. 4d.). Thus the purchasing price is a mere trifle out of the return for the fibre; but the cost of cutting the leaves is another matter, which is always at the expense of the buyer. Carriage may also prove rather expensive, for it takes about 40 tons of leaves to make 1 ton of fibre; it is easy, therefore, to understand that transport becomes pretty onerous if the leaves have to be brought a long distance. It is these expenses which are subject to the greatest variation, reaching, according to conditions, from 25 to 50 rupees per ton of fibre (33s. 4d. to £3 16s. 8d.).

If water power is used to drive the scutching machines, work is conducted very reasonably, but, if steam has to be employed, the cost of fuel does not admit of good profits unless prices are high.

Inasmuch as many plantations make only expenses when fibre is sold at 200 rupees (£13 6s.), they make splendid profits when the price reaches 400 rupees (£26 12s.), as we have seen only a few months ago.

The only machine used in Mauritius for preparing the fibre is the Gratte, which is very similar to the Mexican Raspador.

The Gratte is a primitive but very strong machine, and its use on all small plantations is explained by its simplicity and its cheapness—250 rupees (£16 13s.), without motive power. At Mauritius the machine-house usually has two Grattes, at most, five or six

installed, and these even work very intermittently. The Gratte is a locally-made (Mauritius) machine, requiring for motive power 2 to $2\frac{1}{2}$ h.p. oil engine. The drum revolves at 800 revolutions a minute. It will turn out from 125 (275 lb.) to 150 (330 lb.) kg. of dry fibre in a day of ten hours—that is to say, it will clean from 5,000 to 6,000 kg. (11,000 to 13,200 lb.) of green leaves in that time; two men are sufficient to work it, but, as they work usually only for about five hours, two shifts are employed. The workmen place themselves on each side of the Gratte, wearing leather gloves to protect their hands from the burning action of the juice from the leaves. The base or thick end of the leaf is first put under the drum, the other end is held firmly in the hand; the leaf being thus half-cleaned, the workman draws it out, seizes the cleaned fibres, and inserts the other end of it.

When the leaves are large, only one at a time is cleaned, but if they are small two or three are put in at once. The men are paid by piecework, receiving about 80 rupee-cents. ($12\frac{3}{4}$ d.) per 100 kg. (220 lb.) of fibre.

It cannot be stated exactly how much fibre is yielded per leaf, as some are more mature than others; but it is calculated that on an average 40,000 kg. (88,000 lb.) are required to produce 2,240 lb. or 1 ton of dry fibre.

We have seen that the purchase money of this quantity of leaves amounts to from 10 to 12 rupees (13s. 4d. to 16s.); cutting costs from 25 to 30 rupees (33s. 4d. to £2); cleaning, about the same. So that it may be reckoned that a ton of fibre costs 100 rupees (£6 13s.) on leaving the Gratte.

If the price of fibre is 200 rupees (£13 6s.) per ton, there will be a balance of 100 rupees (£6 13s.) to pay the cost of motive power, washing, drying, baling, and all other expenses up to delivery of the fibre to

the buyer. The carriage of leaves to the machine is always a heavy expense (in Mauritius) simply because there are no cultivated plantations, and that planters content themselves with working lands (self-planted) more or less distant from the factory, where the *Furcræa* and a spontaneous vegetation dispute the ground with each other. The above expenses might be reduced by preparing the fibre on the spot by using a Gratte driven by a small motor, the whole mounted on a carriage which could be moved at will. The only carriage expense incurred would be that of the raw fibre—that is to say, of one-tenth of the weight of the green leaves.

It has been stated here that only the *Furcræa* is worked at Mauritius, but, considering the actual price of the fibre, it might be advantageous to establish new plantations under normal conditions, and, in this case, would it be advisable to stick to the *Furcræa* or to plant in preference true sisal or henequen, the *Agave rigida*, var. *sisalana*?

This last variety, which is cultivated in almost all fibre-producing countries, was introduced into Mauritius some years ago, but as even at that time no new plantations of *Furcræa* were being made, the sisal plant did not increase. Still, the sisal has great advantages over the *Furcræa*, which it much resembles as far as habit of growth and development are concerned. The sisal fibre is much easier to prepare and clean, and the price is always much higher in foreign markets; besides, the yield of fibre is far greater. As far as the yield is concerned, the following two experiments are conclusive. The *Furcræa* leaves came from two different localities—from the Réduit, 1,505 ft. above sea-level, and from the Pailles, a hot, dry locality on the seaboard. All the leaves were cleaned on the same Gratte and by the same workman. There are two varieties of *Furcræa*. One is called the *Aloès*

malgache, whose leaves are thicker and more fleshy, especially at the base. The other is the *Aloès créole*, by far the widest spread. As will be seen by the table below, the second variety appears to be preferable to the first :—

YIELD OF FIBRE FROM LEAVES OF ALOES MALGACHE, ALOES CREOLE AND SISAL.

	First Trial			Second Trial.			
	Sisal from the Réduit	Aloès Malgache from the Réduit	Aloès Créole, Pailles	Sisal from the Réduit	Aloès Malgache Réduit	Aloès Créole, Réduit	Aloès Créole, Pailles
Number of leaves... ..	30	30	—	30	36	30	10
Weight of leaves, kilos ...	36	65	47	37·5	57·5	27·5	13·7
Weight of wet fibre, kilo...	5·100	4·950	4·900	4·400	4·700	2·870	1·650
Weight of dry fibre, kilos	1·510	0·930	1·170	1·580	0·955	0·602	0·365
Dry fibre, per 100 wet fibre	29·6	18·8	23·9	35·8	20·3	21·0	22·1
Wet fibre, per 100 leaves...	14·16	7·61	10·42	11·8	8·2	10·4	12·00
Dry fibre, per 100 leaves...	4·19	1·43	2·49	4·21	1·66	2·19	2·65
Dry fibre in British weight in lb.	9 $\frac{7}{8}$	31 $\frac{1}{8}$	5 $\frac{1}{2}$	9 $\frac{9}{16}$	3 $\frac{3}{8}$	4 $\frac{4}{5}$	4 $\frac{4}{5}$

The result of these experiments shows that the aloe called *malgache* is of inferior quality, and that the plants from the seaboard yield a larger quantity of fibre; but the most characteristic feature is the superiority of the *Agave rigida* (the true sisal) over the *Furcræa*. Admitting that the *Furcræa* gives a return of 2 $\frac{1}{2}$ per cent., which is not always obtained, and that the *Agave rigida* yields 4 per cent. under similar conditions, we have an increase of 60 per cent. on the quantity of fibre obtained from a similar weight of leaves, without taking into account the economy in carriage of the leaves and the advantage of greater facility in extracting the fibre. . . .

After extraction of the fibre of the *Furcræa* in the Mauritius factories, there remains a mass of detritus almost equal to the weight of the leaves manipulated ;

these semi-liquid débris accumulate in the neighbourhood of the factories, where they gradually decompose and form a manure containing the principal fertilisers of the pulp and sap, the value of which we have before pointed out.¹ Of this latter there is only a small quantity in the mass of débris, the surplus running off into the neighbouring streams. Admitting that 1 ton of leaves produces 700 kg. (1,570 lb.) of juice and 300 kg. (660 lb.) of half-dry pulp (which is a fairly correct allowance), we obtain the following results by analysis of the solid residue or refuse and of the liquid collected at the factory :—

	Composition per 1,000 kg.		Residue of 1 ton of leaves		
	Juice	Pulp	Juice 700 kg.	Pulp 300 kg.	Leaves 1,000 kg.
Chlorine	0·07	0·30	0·949	0·090	0·139
Sulphuric acid	0·13	0·21	0·091	0·063	0·154
Phosphoric acid	0·43	0·41	0·301	0·123	0·424
Lime	0·87	4·78	0·609	1·434	2·043
Magnesia	1·19	1·74	0·833	6·522	1·355
Potash	3·09	3·02	2·163	0·906	3·069
Total mineral matter	7·80	17·20	5·460	5·160	10·620
Azote	0·50	1·97	0·350	0·591	0·941

The large content of potash will be noted ; this is principally in the juice, which is partly lost, as we have said. With regard to the unpleasantness of the aloe manure, it may be observed that the decomposition is relatively very slow.

Ten tons of leaves of *Furcræa gigantea* and 3 cwt. of *Furcræa Lindenii*, a large-leaved, fleshy, variegated variety, were treated in June, 1906, at St. Helena

¹ I have omitted the analysis here referred to. The manurial value is set down at 65 rupees (£4 6s.) per ton of fibre exported. Taking the ordinary price paid for the leaves required to produce 1 ton of fibre, we get 13·30 rupees (about 17s.) ; consequently, the aloe leaves are sold at one-fifth of the value they would represent as manure.

Penal Establishment, Moreton Bay, and yielded 3 cwt. 3 qr. and 6 lb. of fibre respectively.

IXTLE FIBRE.

This is the production of an agave called *Agave Lechuguilla*, of Texas. The annual production of this fibre in the San Luis Potosi State of Mexico, is about 5,000 tons, of which one-third is exported to Europe, and the remaining two-thirds to the United States. About one-third of the fibre shipped to the United States is resold in Europe. The plant is hardy enough to withstand sharp frosts, and thrives naturally on land practically worthless for other purposes. The enormous increase during recent years in the value of the Mexican fibre from this source, with its main market in the United States, appears to justify experiments in its introduction into other countries.

The price of the fibre, both in American and European markets, has been steadily advancing during the last ten years. This is partly due to the fact that American manufacturers have largely adopted it in the manufacture of rope and twine, and to the advance in price of henequen (sisal hemp) and Manila fibres. The cost of production has also increased. In 1894 it cost 2s. 9d. to produce 100 lb., selling at 6s. In 1904 the cost of production rose to 5s. 6d. per 100 lb., but the selling price advanced to £1 os. 8d.

Ixtle lands to-day are some of the most valuable properties in the State, owing to the fact that the *Lechuguilla* plant requires no cultivation, and reproduces annually. Being an atmospheric plant, it is not dependent on the rainfall, although a moderate amount of moisture assists the growth of the plant, and the resultant fibre is of better quality than in dry seasons. Mr. Consul L. J. Jerome says that an average ixtle gatherer can scrape 15 to 20 lb. of fibre

per day, and that, although a number of machines have been invented for cleaning the leaves, none have given satisfaction owing to their being too heavy and unwieldy, and also owing to their having to be run by steam power. The plants are scattered over an area of 200,000 or 300,000 acres, which makes the cost of carrying the leaves to the machine an expensive item, especially when it is remembered that not more than 5 per cent. of fibre can be extracted from the leaf. Water, also, for the engines, is a scarce commodity on the large ixtle plantations, rendering the use of steam-driven machines practically out of the question. Probably since this was written oil engines have been introduced.

There is a large rope factory established at Sabinas, in the State of Coahuila, which is devoted solely to the manufacture of twine, rope, cord, bags, sacks, &c., from the ixtle fibre. The factory employs 500 hands.

PRODUCTS OF THE AGAVE.

Pulque, the national drink of the tableland round the city of Mexico, is made from the agave, as is also a spirit called mezcal. An enormous quantity of this spirit is distilled every year, and a still greater quantity of pulque. Some 50,000,000 bottles of these liquors are sent annually by rail to the city of Mexico, and the daily pulque trains to the capital are a considerable source of revenue to the railway companies. The main line of the National runs principally through pulque country.

The beer is manufactured by cutting off the head of the flower pole as soon as it makes its appearance in the centre of the leaves. Then a hole is scooped out in the head of the trunk, which will hold several pints. All the vast quantity of sap which would have gone to nourish the quick-growing pole collects in this

hole, which is kept bailed out by a labourer, and the sap is poured into pig-skins, where it undergoes a sort of fermentation. The brandy, or mezcal, is distilled from the young pole itself.

The principal product of the agave, however, is the fibre, and one of the most important manufactures from it is binder twine, for which purpose it is better adapted than any other fibre. When we consider the enormous areas under wheats in many parts of the world, we may cease to wonder at the great demand for sisal fibre. The enormous stretches of prairie lands under wheat in the United States of North America and in Canada, as well as in some States of South America, enable us to understand why £3,000,000 worth of the fibre are annually purchased in New York from Yucatan alone. In Australia we have, approximately, 6,000,000 acres under wheat, and although strippers and complete harvesters are used to some extent, yet thousands of reapers and binders are at work at harvest time, consuming from $2\frac{1}{2}$ to 3 and even 4 lb. of twine per acre. If all this area had been cut by reaper and binder, the total cost of the twine, at 7d. per lb., duty paid, would have amounted to £525,000. The raw material required in its manufacture would total over 10,000 tons, including waste at the ropeworks. The value of this quantity at £35 per ton would be £350,000, which would have gone into Queensland farmers' pockets, in addition to the value of their other crops. It will thus be seen that there is an opening for a very large trade in the product.

An extract of the leaves is used to make soap. A strip of the pole makes a splendid razor-strap, owing to the silica it contains. The roots are used in Europe to mix with sarsaparilla. The fibre makes excellent paper, so does the pith of the flower pole. In fact, sisal is the most highly approved of all fibres

for the purpose, as it makes a strong, tough, smooth paper, which feels like oiled paper ; and, even when unsized, may be written upon without the ink running.

SUMMARY.

From the foregoing dissertation on the cultivation and preparation of sisal fibre, and from what I have shown as to its peculiar adaptability to our Queensland climate, and what markets are available for the product, the reader cannot fail to come to the conclusion that there is a grand future for the industry in this State. So long as people will not entertain exaggerated ideas of the profits to be derived from sisal cultivation, and will average the lean years with the good ones instead of, as some do, only talk and dream of "palmy days," all will go well. They must also be contented to look upon a yield of half a ton of marketable fibre per acre as an average crop, if they wish to avoid any probability of disappointment. It is quite possible to obtain a yield of from 15 cwt. to 1 ton per acre, and, judging by the results already obtained here, and by the superior weight of the Queensland leaf, the higher yield is most likely to be obtained,¹ but the instance of the heavy yield at St. Helena cannot be taken as one which will be repeated on regularly laid-out plantations.

As to a market for the fibre, there is a large demand for it in the United States, Europe, and the southern States of the Commonwealth. Japan, also, promises to be a good market. There is also evidence that the market price has increased in proportion to the increased production, so that it is highly impro-

¹ During 1910, Mr. T. H. Wells, of Farnbro', Childers, obtained $1\frac{1}{2}$ tons of marketable fibre per acre from a large area of 3- to 4-year-old plants.—A. J. B.

bable that this generation, at least, will see any great diminution in prices.¹

The question as to the area of a plantation which will give the best returns is best answered by saying that the larger the area the greater the profit. A plantation of 500 acres is to be preferred to one of 100 acres. This fact need not, however, deter anyone from planting a small portion of his farm with sisal, provided he is in the close neighbourhood of a plantation where large machinery is in operation. For instance, a man plants 20 acres of sisal. This should return 10 tons of fibre, worth, say, £350. He may either sell the leaves to the neighbouring factory, or could have them worked up at a reasonable price. The weight of leaves to produce 10 tons of fibre would be from 250 to 300 tons. This would seem a great quantity to remove, but, if we compare it with the tonnage of sugar-cane from 20 acres, we see that a heavy crop of 30 tons of cane per acre would amount to 600 tons. On the other hand, the 600 tons of cane are worth from £300 to £600, or £15 to £30 per acre, less expenses for cutting and loading at 3s. to 4s. per ton, whereas 300 tons of sisal leaves, although producing fibre worth £350, would, deducting 50 per cent. for all expenses, be worth about £175, or about £8 15s. per acre. But a farmer, with two sons old enough for field work, could take off the crop himself with a Raspador, which would turn out from 60 to 100 lb. of fibre a day, the cost of labour being retained in the family. It used to be said that only large sugar plantations would pay, but when the large plantations were cut up into small farms and the central mills were established, it was found that the small cane-farmers could make a

¹ But in March, 1908, the price fell to £30, and in June to £24 per ton.

very comfortable living by selling the cane to those mills, and it will probably be found that the same result will happen in the case of the sisal hemp industry. Many farmers in the United States are said to add from £100 to £300 per annum to their incomes by planting the waste portions of their land with sisal. I do not know what facilities they have for turning out the fibre or selling the leaves, but the fact remains that they derive considerable profit from the industry.

With respect to the merits and commercial value of the *Furcræa gigantea*, as compared with sisal, it has already been explained that *Furcræa* fibre—that is, Mauritius hemp—is not so valuable as sisal fibre. Still, if sisal plants are not obtainable, there is no reason why the *Furcræa* should not be planted.¹ The yield of fibre is large, and the leaves grow to a greater length and are heavier than sisal leaves. On the other hand, the fibre is finer and weaker, and does not possess the lustre of the sisal fibre. There is, however, a good and constant market for it.

CHARACTERISTICS OF TRUE SISAL HEMP.

The true sisal hemp of commerce is known to botanists in two varieties, named *Agave rigida*, var. *elongata*, and *Agave rigida*, var. *sisalana*, respectively. The former of these is the principal sisal plant of Yucatan, the latter that of the Bahamas, and the general opinion seems to be that the *sisalana* variety is the better. Plants of the former variety introduced direct into Sylhet from Yucatan have not been very luxuriant, and for the Indian tea districts the *sisalana* variety has hitherto proved to be preferable.

¹ In June, 1910, fair current sisal fibre was quoted at £25 per ton, best at £27, and Mauritius hemp at £27 and £27 10s. per ton in London.

This variety may be described as possessed of only a very short trunk with straight stiff leaves, from 4 to 6 ft. long and 4 to 5 in. wide. These leaves have a bloom upon them, giving them a blue tinge, but when this is rubbed off they are dark-green in colour, much greener than the large common blue aloe of the north-west. The edges of the leaves in a typical plant are smooth, without thorns, or with thorns so small as to be hardly noticeable. But this character of thornlessness is an extremely variable one. The young bulbils and plants for the first year of life often, in Sylhet, at any rate, show decided thorns on the side of the leaf, which disappear, or nearly so, as the plant becomes older. More than this, it is not at all uncommon for plants raised from bulbils of a thornless plant to possess thorns throughout life, and to be indistinguishable (until the flowering stage) from the Yucatan variety—*Agave rigida*, var. *elongata*. The spine at the tip of the leaf is an exceedingly strong one, often twisted, and purplish black in colour on all the plants.—Concerning this, see the first section by Dr. Mann and Mr. Hunter.

MAGUEY CULTIVATION IN MEXICO.

The maguey plant, also called "century," "yaxci," or "henequen," is a species of the genus *Agave*. The fibre, after being extracted, is generally known as sisal, ixtle, or henequen. This fibre is mostly shipped to the United States, where it is manufactured into sacking, cordage, and binder twine, the finer qualities being used for making fancy hammocks and other similar articles. Yucatan leads all the States of Mexico in the production of the maguey plant. This new enterprise is making this State one of the wealthiest in the Republic, and it is outstripping any similar industry in point of rapid increase.

The maguey plant is found in its wild state in many of the States of Mexico. It thrives on poor, rocky lands, where scarcely anything else will grow (as shown in the illustrations in the Mexican Section). The climatic conditions of Mexico are very favourable for the cultivation of maguey. A machine for the extraction of maguey fibre, which is in general use, and which gives very good satisfaction, is manufactured in Mazatlan. This machine weighs 850 kilos (1,870 lb.), and costs, ready for shipment, 350 dollars (£35) Mexican, and with cap or cover 450 dollars (£45). It will strip about 7,000 leaves in a day of ten hours, which should yield 14 arrobas (350 lb.) of fibre. Further details were recently given in *The Philippine Bureau of Agriculture Press Bulletin* No. 1.

ZAPUPE v. SISAL FIBRE.

Mexico produces in limited quantities a most valuable fibre from an agave similar to the henequen or sisal agave. This fibre is said to be superior to sisal in many respects. It has not yet been exported in commercial quantities, the demand for home consumption for the manufacture of rope, binder twine, bags, cordage, &c., having always exceeded the supply. There are only two plantations in Mexico equipped with steam machinery for extracting the fibre. All the seed has been bought up to the end of next season (1910).

Mr. R. M. Green, British Vice-consul at Tuxpan, has forwarded to the Board of Trade, through the Foreign Office, a sample of the fibre, with a report upon it. He also forwarded the report of the United States Consul on the subject, together with a photograph of the zapupe leaf and articles manufactured from it.

Since the first edition of this pamphlet appeared, I have obtained fuller information on this fibre plant,

through the medium of the *Mexican Investor* and the *Tropical Agriculturist*, Ceylon, so that, in continuation of the above, the following report by Mr. L. J. Nunn, British Vice-Consul at Vera Cruz, Mexico, is of considerable interest. Unfortunately, we are still ignorant of the specific identity of this agave.

ZAPUPE CULTIVATION IN MEXICO.

Of the many experiments that have been made with fibre-producing plants to discover one that would equal for production and results the henequen or sisal of Yucatan, all seem to have given but little result with the possible exception of the zapupe, to the cultivation of which, in a limited way, a considerable degree of attention has been devoted in the State of Vera Cruz during the last three or four years. Attempts have been made, as is well known, in various parts of the world, but more especially in some of the islands of the West Indies, to raise sisal or henequen, but in general these attempts have been failures, the consensus of opinion being that there are certain peculiarities in the barren and arid plains of Yucatan which, together with climatic conditions, render the land unrivalled for the cultivation of this particular class of hemp-producer. It would seem, however, that in the zapupe a rival to the henequen or sisal has been discovered, that can be produced under equally as economical conditions, and which will give as good if not better results under more varied conditions of soil and climate.

Botanists, it would appear, have not yet decided on the exact classification of the zapupe, and although it resembles in many points the henequen, it can only be said that they are both of the agave family.

The first experiments in the cultivation of the zapupe were undertaken in the year 1901 or 1902, on

a small scale, on some lands cleared for this purpose in the Canton of Tuxpan, in the State of Vera Cruz, where it is found in its wild state, and it is estimated that in the same vicinity there are now set out over 5,000,000 plants in various stages of growth.

The cultivation of the plant requires no particular skill, nor does it require much attention, a point of considerable moment in countries where labour is scarce and apt to be unreliable. The usual methods adopted are to take the young shoots when they are but a few inches high, cut them clear from the parent plant, and set them out in carefully-prepared nurseries, where they are allowed to remain from eight to ten months, by which time they will have assumed a height of from 1 ft. to 2 ft. above the ground. At this stage they are then transplanted to ordinary lands, all the preparation required being to turn the ground up with a plough and set the young plants in the furrow, banking the soil up around them so that they may be well covered. One of the reasons for this is that when the young plants are lifted from the nursery all the roots are cut off, that part where the roots should be resembling more or less the sharp end of a tent-peg, so closely are they cut down. As a rule, the furrows are run in the usual parallel manner, about 7 ft. apart, with a distance between each plant of about 5 ft., which would give a little over 1,000 plants to the acre. Between three and four years subsequent to transplanting, the plant will bloom unless pruned, when flowering will not take place for a matter of fifteen years. In order to increase the fibre-producing power of the plant, the flowering period must be kept in check as long as possible.

At from four to five years old the cutting of the leaves can be begun, the plant continuing to produce for a term of eight to ten years. Cutting takes place three times a year, each yield per individual plant

being from about twenty-five to thirty leaves, the weight of fibre per leaf amounting to probably not quite $\frac{1}{2}$ oz., so that each plant would give per year about $2\frac{1}{2}$ lb. of fibre.

From three years and onwards each plant will give off anywhere from two to a half dozen shoots, and, if allowed to flower in its early stage, from the stalk which runs up from the centre to a height of 12 ft. and more, it is possible to cut 100 or more slips.

Although up to the present no extensive plant has been erected for the treatment of this fibre by machinery, there is little doubt as to the confidence in its future possessed by those engaged in its cultivation, for whereas experiments as to the possibility of its uses and production were only begun in 1901, it is safe to say that at present there are fully 4,000 to 5,000 acres of ground now cleared and set out with 4,000,000 to 5,000,000 plants in various stages of growth.

The best localities for the cultivation of zapupe are gently sloping plains or mountain foothills, with a soil fairly rich to poor and of not too porous a nature. Drainage must be good, as if the plants get set too long in stagnant water, the roots will rot, and in general the growth and production of fibre will be retarded. As the plant is essentially tropical, it is perhaps needless to say that its cultivation at any considerable altitude is an impossibility; the best results, in fact, will be obtained where the atmosphere is warm and humid, and with but slight variations in the temperature. A too sandy soil should be avoided as absorbing too quickly the surface moisture on which the shoots, especially from the parent plant, are dependent. A clayey soil, again, is equally bad, as it seems to cause the roots to double and break in their endeavours to spread.

A rough estimate would show that the outlay for

tending the young plants in the nursery, preparing the ground for transplanting, together with cost of the plants, would be approximately :—

	Dollars
Shoots, per 1,000... ..	35.00
Sowing and tending in nursery, per 1,000 ...	7.50
Preparing ground and planting	7.50
Total (apparently Mexican dollars of 2s.) ...	50.00

Up to the present time the general uses to which this fibre has been applied have been limited to the making of food and game bags, lariats, and a species of gunny cloth, but more recent experiments have demonstrated its adaptability for working up into rope, and it is on this ground that several local companies have been formed and are projected for the raising of this plant on a large scale in order to compete with the henequen or sisal hemp growers of Yucatan, in the production of a rope-making fibre.

Comparison between the respective merits of sisal hemp and zapupe, from the point of view of the cultivator, show many points in favour of the latter, if, as is hoped, the fibre of the zapupe should prove to be equal for commercial purposes to that of the sisal. For example, the rapid growth and development of the zapupe is quite extraordinary. In from three to four years, in many cases, the plant will have arrived at a stage where the gathering or cutting of the leaves may be taken in hand, whereas the henequen or sisal takes fully six years to arrive at a condition of sufficient maturity to permit of the cutting of the leaf.

From the point of view of yield of fibre, the difference in favour of the zapupe is again very marked, as the following data will show :—

	Zapupe	Henequen or Sisal
Plant... ..	1	1
Yearly yield of leaves ...	80	25
Cuttings per annum ...	3	2
Weight of fibre per leaf ...	$\frac{1}{2}$ oz.	1 oz.
Product	$2\frac{1}{2}$ lb.	$1\frac{1}{2}$ lb.

It will be seen from the foregoing that the zapupe will yield in a year fully a third more weight of fibre than can be obtained from the sisal ; but, on the other hand, the labour and increased work entailed make it doubtful whether the revenue derived from the extra weight of fibre produced by the zapupe would not be more than swallowed up by the excess occasioned in expenditure. For instance, in the zapupe, three cuttings per year are necessary. Eighty leaves have to be culled and carted to the decorticating machine. The eighty leaves have to be put through the scraper three times, and the refuse to be removed is equally as great in volume, whereas, with the henequen or sisal, there are only twenty-five leaves per plant to handle from the plantation to the machine shed, the same results are obtained with two scrapings as are produced by three in the case of the other plant, so that it remains quite a question as to whether the larger quantity of fibre obtained really does offset the increase in expenditure that so much extra labour must entail. This scarcity of labour in the hot lands of Mexico, especially near the coast, is, and probably will be for many years to come, the most formidable difficulty that the planter of this and other produce has to contend with.

It must, however, also be borne in mind that the cultivation of the sisal is one to which for the last thirty years and more the closest study has been given, and every possible experiment tried, with the object of increasing the yield and effecting, by improved machinery, economies in the expense of treatment, the result of which has been that, whilst sale prices have remained at a most profitable figure, the cost of production has steadily decreased.

That there is a bright future for those engaged in the production of zapupe there can be but little doubt, the value of the fibre having been proved beyond

the experimental stage, in addition to which it has been shown that it possesses, both for toughness and, tensile strength, the necessary qualities to admit of its being worked up into "binder twine," an even more profitable use than its manufacture into rope. As a matter of fact, probably over 90 per cent. of the sisal to-day produced and exported from the peninsula of Yucatan to the United States is made into "binder twine," and even with this there is a constant demand for other raw materials as substitutes.

It may prove of interest to prospective zapupe planters to learn the gigantic strides that have taken place in the production of sisal during the last twenty-five years, which are shown by the following table, showing the quantities and value of the exports of this produce from Yucatan alone. It is also worthy of note that at its lowest selling price of $3\frac{1}{2}$ cents Mexican per lb. (with the Mexican cent about equal to $\frac{1}{4}$ d.), there was still a margin of profit to the planter, whose gains were simply notorious throughout the country when the maximum price of $19\frac{1}{2}$ cents Mexican per lb. was attained:—

Years	Number of bales	Weight in metric tons	Total value of exports	Years	Number of bales	Weight in metric tons	Total value of exports
			£				£
1880	112,911	18,179	177,757	1894	373,773	61,605	684,817
1881	154,730	24,911	272,656	1895	383,413	61,729	611,219
1882	150,585	24,244	273,655	1896	397,163	65,762	726,423
1883	202,805	32,651	353,750	1897	419,975	70,545	821,869
1884	261,137	42,043	347,164	1898	418,972	68,834	1,891,807
1885	267,478	43,064	333,481	1899	445,978	73,190	2,021,124
1886	242,791	39,089	392,972	1900	499,634	81,093	2,261,603
1887	224,865	36,283	589,442	1901	517,519	83,191	2,278,345
1888	218,129	35,118	664,125	1902	528,246	83,993	3,643,279
1889	252,432	40,641	1,024,369	1903	590,430	93,058	3,333,115
1890	279,907	45,079	523,030	1904	606,008	97,205	3,202,258
1891	323,585	52,065	657,168	1905	597,289	96,534	2,692,543
1892	363,881	58,584	839,994	1906	599,568	97,198	2,724,752
1893	360,857	58,097	846,713				

(see the Royal Botanic Gardens *Kew Bulletin*, No. 10, 1907).

In the original brochure plates of the zapupe plant, leaves, and flower pole, were reproduced from vol. xviii, No. 3, of the *Transactions of the Academy of Science of St. Louis*, illustrating a most interesting account of the Mexican Fibre Agaves known as Zapupe, by Dr. William Trelease, to whom I am indebted for several valuable treatises on fibre plants.

Under the heading, "New Fibre Plant, the Zapupe," the *Mexican Investor* (October, 1907), says: "Zapupe culture continues to be a field of large investment for many capitalists of this city, and also for many investors from different parts of the United States. Within the past month there have been no less than six large concerns, two of which are located in New York and one in Kansas City, that have sent their representatives here to look carefully into the question of zapupe culture."

The statement of these representatives, after their investigations were completed, and when they were on the eve of departure to make their reports, has invariably been that they saw a great future ahead for the industry of raising zapupe and handling the fibre.

Deals in land suitable for raising the fibre plant have been made to the number of three, and it is shown that several others are pending. With these there is a strong suspicion that other deals have been put through on the quiet by parties who wanted to get everything ready before anything leaked out about their movements.

Samples of the wonderful fibre plant, which have been submitted for examination and analysis to experts in New York, have served to bring back the most glowing reports. The experts say the zapupe fibre is far superior to henequen fibre, can be used in the manufacture of a much finer grade of material, and as such will command a good deal higher price.

The nature of the plant has many things to recommend it to the planter. It is very hardy, runs little danger from the depredations of stock, matures quickly, and lasts for five years, is not dependent to any extent on climatic conditions or moisture, and the fibre is extracted from the leaves with economy and speed.

There are several grades of zapupe, and planters have not as yet come to an agreement as to which is the best. The industry is in its infancy as yet, and many things are still open for argument.

If henequen made so many millionaires in Yucatan and Campeche, it seems certain that more will be made by zapupe in Tamaulipas and Vera Cruz. Planting at present is more in the northern part of Vera Cruz, though there are large tracts set out in Southern Tamaulipas as well.

A New York company has been formed to go into zapupe-planting on a large scale, and the *Investor*, on this point, says :—

“C. H. Barkley, who was here (Tampico) some time last summer in connection with an accountant's investigation, and at that time became well known here, has become interested in the zapupe business of this section, and, with the able assistance of M. Poindexter of this city, will form a company in New York to carry on an extensive planting business. Mr. Barkley is a resident of New York, and is said to have a large acquaintance amongst Wall Street capitalists.

“Much planting has already been done in this section, probably 500,000 plants having already been set out. Another year, it is believed, will see this number more than quadrupled. Within five years Tampico should be a great fibre-exporting port. Measures are now being taken to get in stock hundreds of thousands of the young zapupe scions

for planting. The available number of these is now somewhat limited, but this is only a temporary difficulty."

FURCRÆA LINDENII.

This plant may be seen in many Queensland gardens. It bears immensely long, very thick leaves, which are striped green and yellow. They are smooth without spines. Owing to their thickness, they require to be passed through rollers before extracting the fibre. One hundredweight of leaves will yield from 2 to 2½ lb. of marketable fibre, equal in every respect, if not superior, to that of *F. gigantea*.

MURVA OR BOWSTRING HEMP.

(*SANSEVIERIA ZEYLANICA*.)

There are three species of sansevieria to which the name of Bowstring hemp is given; but there are a dozen species in the genus. The three species are: *S. Guineensis*, *S. zeylanica*, and *S. latifolia*, the first-named being known as African Bowstring hemp. *S. zeylanica* is the best known, however, and is common on the Ceylon coasts, whence it derives its name. The leaves are from 4 to 5 ft. long, although, according to the report of the United States special agent in charge of fibre investigations, Mr. R. C. Dodge, from which we take these remarks, he has cleaned leaves in Florida that measured 7 ft., and 100 lb. of selected leaves in one lot cleaned averaged 6 ft. in length.

The *Sansevieria zeylanica* is a stemless perennial, belonging to the Hæmodoraceæ, and is well known in many Queensland gardens. The dark-green radical leaves are linear-lanceolate in shape, and are freely spotted on each side, with lighter shades of the same colour, often with dark transverse bands. The fibre possesses in a wonderful degree those properties

demanding of a first-class cordage material. It is white, fine, soft, pliant, and lustrous, and resembles pineapple fibre in many of these qualities. Its resistance to moisture is very marked, and its tenacity is equal to sisal, to which, in most other respects, it is superior. It is propagated by division of the rhizomes, or the leaves may be cut into lengths of a few inches, and placed in the ground, when suckers will show in a few weeks. The plants soon become established, and a full crop may be harvested in about two years. After cutting, the growth becomes denser, and the plants will continue productive for many years. No extremes of rain or drought need be feared, as *Sansevieria* appears to be indifferent to either, but it will not stand frost. Forty pounds of leaves yield about 1 lb. of dry fibre and two crops, consisting in all of about 3,500 lb., may be obtained from an acre of about 3,000 plants.¹

In the *Kew Bulletin* for April, 1887, it is stated that plants of this genus require a rich moist soil, and a comparatively humid climate, and that, being essentially tropical plants, they do not thrive in a temperature less than 60° F. Under such conditions, they grow rapidly, and establish themselves permanently by means of their large spreading rhizomes or underground stems. It is true they will grow in comparatively dry districts, and even in soils strongly impregnated with salt. The strength of the fibres, as tested by the Agri-Horticultural Society of India, was found sufficient for hawsers and cables, whilst their fineness and tenacity are attested by their being used by jewellers for thread upon which to string

¹ But far more than 3,000 plants can be raised on an acre, because, if planted 2 ft. by 2 ft. apart, the number of plants would be 10,190, and at 1 ft. each way 43,569. Where the plants have taken full possession of the land, there would probably be 50,000 plants per acre.

pearls and precious stones. It is, however, too fine and too valuable a fibre for cordage, in view of the fact that manila, sisal, and common hemp are to be obtained abundantly, and are sufficiently strong for the purpose.

The native method of preparing this fibre is to place the leaves upon a smooth board, then press one end of the leaf down with one of the great toes, and with a thin bit of hard stick they scrape the leaf from them and very quickly remove every particle of pulp. This is also accomplished by steeping the leaves in water until the pulpy portion decays, when the fibre is washed and cleaned, though, in some cases, steeping injures the fibre. It is estimated that 40 lb. of fresh leaves, $3\frac{1}{2}$ or 4 ft. in length, will yield 1 lb. of clean fibre, or over 1,600 lb. per acre, at a gathering, and, given favourable conditions, two such gatherings may be assured annually.¹

The U.S. Department of Agriculture in 1892 received a ton of sansevieria leaves, which were cleaned at the experimental fibre factory at Biscayne Bay, and a quantity of superb fibre was obtained. The leaves varied in length from $2\frac{1}{2}$ ft. to 7 ft., and it was possible to select over 100 lb. of leaves that averaged $6\frac{1}{2}$ ft., and which gave fibre averaging 6 ft. in length. The U.S. expert says: "Careful experiments, based on the quantity of sansevieria fibre produced in our experiments, would fix the yield at about 40 lb. of fibre to the ton of leaves. The machine used made too large a percentage of waste. The waste was not weighed, but it is very safe to state that, with only reasonable wastage (cut fibre and fibre drawn out with the pulp), the yield of fibre per

¹ From 10 lb. of sansevieria leaves, received from the Brisbane Botanic Gardens, I obtained 4 oz. of beautiful fibre, 4 ft. in length, the waste from cleaning not being included in the weight. This is equal to 1 lb. from 40 lb. of leaves.

ton would come nearer to 50 lb. Even if this is considerably lower than the yield of sisal hemp, the quick growth of the plant, the ease with which it can be harvested and handled, and the higher price of the fibre, will probably more than make up for the difference in yield of clean fibre. A new machine (of which Major Boyd gave a drawing), described as being adapted for extracting murva fibre, was placed on the market, and it is extensively used in Uganda, in Africa—viz., the Finnigan-Zabriskie machine made in Paterson, New Jersey, U.S.A. This machine is in operation on Mr. T. H. Wells' plantation, Childers. He works it for sisal fibre, and finds the loss by waste to be from $1\frac{1}{2}$ to $1\frac{3}{4}$ per cent. of fibre. If this trouble can be overcome, the profit on the output will be largely increased. The Ajax single drum automatic machine, also described and illustrated by Major Boyd, was said to be effective in cleaning *sansevieria* leaves.

The material is too good for cordage, in the usual acceptance of the term. It is so much better and finer than the cordage fibres, so-called, that it would doubtless find a use in the manufacture of fine twines, and, I think, with proper preparation, could be made into a fair spinning fibre, and possibly be employed in some new form of manufacture. The fibre is fine, white, and lustrous, the leaves yielding readily to treatment in the machine in the fresh state.

PROPAGANDA AND, CULTIVATION.

For convenience, the leaves are cut into sections about 4 in. long, and inserted into boxes of earth to the depth of about 2 in. ; the soil must be moderately dry, as too much moisture will cause the leaves to rot ; the boxes must be placed in a moderately shady place, and in a few weeks' time the cuttings will put out numerous fibrous roots, which will soon be followed

by suckers. The plant can also readily be propagated by its rhizomes or roots, which grow without any difficulty.

Sansevieria requires good rich soil to succeed well, and will, under favourable circumstances, acquire its full growth in about twelve months' time; ordinarily, however, it will not acquire its full growth until some time in the second year.

When once the land is stocked with its growth, it will always, when cut, get a full growth from the roots inside of twelve months, so that it is perfectly safe, after the second year, to count on a full crop every year, the growth each year becoming denser, and in a few years becoming so thick that it would appear impossible to cultivate it, which, however, appears to be needless, as, when once fully established, it takes entire possession of the soil, entirely eradicating everything else there. It does not appear materially to exhaust the soil, as it will grow for a number of years in the same place, and continue to make a vigorous growth.

Sansevieria is essentially a tropical plant, and will not stand continued frost. It will, after reaching maturity, if not cut, stand without injury for a number of years, the plant, at the end of that time, affording just as good fibre as in the first or second year of its growth. Mr. Dodge says: "I am satisfied that a plantation would last over ten years without any necessity for renewing it, or for interfering with it in any manner.

"*Sansevieria* will, after it is well established, afford a crop of 5 tons of cleaned fibre per acre, worth, upon estimate, about 100 dollars (£20) per ton.¹

¹ In view of recent quotations this is about 50 per cent. below value. In December, 1907, *sansevieria* from Uganda, Central Africa, was quoted in a French journal at £46 13s. 4d. per ton.

"I selected a few square feet where the growth was thickest, as an experiment, to show how much a crop was capable of producing. I cut and cleaned the leaves, and found they gave at the rate of $13\frac{1}{2}$ tons of clean fibre per acre. I do not believe, however, that the average crop will go over 5 tons per acre, which I consider a fair estimate."

HARVESTING MURVA.

As murva grows thickly together, the question of taking off a crop to the best advantage is a very important one. In a well-grown field ready for cropping the bulk of the leaves will have a height of from 4 to 6 ft. But there will be thousands of young leaves either just above ground or ranging from a few inches to 2 or 3 ft. in height. The question is how to harvest the long leaves without destroying the short ones. In countries where labour is cheap as in Uganda, New Guinea, the Solomon Islands, Java, and other countries with a teeming coloured population, no difficulty need be experienced in cutting the mature leaves only, taking each singly. Expert hands could thus cut 3,000 to 4,000 leaves per day. The young leaves would be left to form a succeeding crop a few months later. By this method the crop would be practically continuous. But in a country like Queensland, where wages and living are very high, it will doubtless be necessary to adopt some other plan for the expeditious removal of the crop at a minimum of expense. Since murva has not been grown anywhere in this State on a commercial scale, as in the case of sisal hemp, we have no data to go upon based on experience. There is one plan of harvesting which might be adopted, and that is to mow the field as is done with lucerne, but this is obviously most wasteful, as all the young leaves

which would give a crop four months after the first cutting are destroyed, and at least twelve months must elapse before a fresh set of leaves arrives at maturity. The cutting in this case does not, of course, destroy the roots and rhizomes producing new plants, but it seriously affects the yield, and only allows of one crop a year, if so much.

The treatment of the leaves next demands attention, and it may be stated at once that retting in water is most undesirable and very injurious to the fibre, at any event so far as colour is concerned. A fibre of a beautiful, brilliant white lustre will bring a higher price than a dull brown sample. This dull colour is the invariable result of water retting. There are several machines advertised as being adapted both for sisal and other fibres, including sansevieria or murva. But the heavy blows delivered by the beater bars of a powerful sisal-scutching machine, and which are necessary in treating stout sisal leaves, are too forcible for the more delicate murva, and when the latter leaves are passed through the more powerful sisal machines not only is there considerable waste of fibre, but the leaves are liable to be cut to pieces by the beater bars. It is claimed for the "Ajax" that no injury to sansevieria fibre results from their treatment by this machine.

CHAPTER III

CEYLON¹

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THE sisal hemp plant (*Agave rigida* var. *sisalana*) is one of a number of cultivated varieties indigenous to Mexico. Sisal hemp is grown largely in Florida and the Bahamas, in British East Africa, Java, and the Philippines, &c.

The fibre is in strong demand for binder twine, and, with the increasing use of harvesting machines throughout the world, the prospects before sisal cultivation are promising. It has been estimated that sisal provides the fibre for fully 90 per cent, of the world's consumption in binder twine.

In addition to binder twine, hawsers and stout ropes are also prepared from the fibre.

The market price for the fibre fluctuates; during the current year quotations in the London market have been from £40 to £45 per ton, and for tow £27 to £30 per ton.

INTRODUCTION TO CEYLON.

In September, 1890, a consignment of sisal plants was received through the Royal Botanic Gardens, Kew, and planted out at Peradeniya, "the plants growing luxuriantly."

In 1906 it was reported that "the plant was

¹ These notes include a special reference to Ceylon in 1927.

growing fairly well in the Botanic Gardens at Anuradhapura."

In October, 1909, 4 acres were planted at the Mahailuppallama Experiment Station, North-Central Province, with bulbils from the Experiment Station, Peradeniya. "The plantation developed promisingly."

Tests for the determination of the fibre content were made as soon as the crop matured and with satisfactory results. No systematic harvesting on any scale was however done.

In 1918-19, 18 acres were planted with suckers at the Experiment Station, Anuradhapura, and this plantation justified the erection in 1922 of a small "gratte" of the raspador type as used in Mauritius for dealing with small plantations of about 30 acres. This machine, which consists of a single drum driven by an 8-horse power oil engine and capable of an output of 1/10th ton of fibre per day, has been in regular use during the years 1923-26, and has proved satisfactory. The cost of the installation was Rs. 8,500.

In 1919, a syndicate was formed to take over the Government Experiment Station, Mahailuppallama, and the neighbouring jungle land and extend the cultivation of sisal. This syndicate developed into a company known as the "Ceylon Hemp and Produce Company, Limited." In the first instance 522 acres were planted in sisal, and a further area of 641 acres is now being developed. In 1924, a large Robey type decorticator, driven by steam and capable of an output of 1½ tons of fibre per day, was installed and is in use.

The original area (4 acres at Mahailuppallama Experiment Station) served to supply suckers and bulbils for the plantation at the Experiment Station, Anuradhapura. The plantation belonging to the Ceylon Hemp and Produce Company was planted from bulbils secured from the same source.

HABIT OF GROWTH.

The roots of the sisal plant feed near the surface and do not descend to any great depth, seldom more than 12 to 18 in. in hard clay and loose rocky soil, respectively.

When the plant has become fairly established in the field, the main stalk throws out underground runners or rhizomes. The point of each runner tends to come to the surface of the soil and forms a bulb, known as the sucker; this sucker takes root and leads a semi-detached life.

Suckers are constantly appearing after the first year and develop in clusters round the parent plant.

Towards the end of the third year the lower leaves ($2\frac{1}{2}$ to 2 ft. in length) assume a horizontal position and change somewhat in colour.

Such leaves are mature; and as the plant grows older more leaves mature, which however are longer and wider and may attain, at the age of five years, a length of 4 to 5 ft. At a certain age, which in Ceylon appears to be in the fifth or sixth year, the plant throws up a pole or flowering stem 20 ft. high. The flowers are produced in dense clusters at the ends of short lateral branches, and after a while buds appear in the axils of the flower stalks. From these buds arise small plants, known as bulbils, which grow to the length of a few inches and then fall to the ground, where they soon take root.

After the production of the bulbils the whole plant withers and dies.

About 2,000 bulbils are produced from one flowering stem. Suckers attached to the main plant at this time may throw out a central stalk to a height of 3 or 4 ft. bearing diminutive flowers and bulbils. They will invariably do so if the pole of the parent plant is removed at an early stage. This stage in the life of

the sisal plant, "the poling stage," and the time of its occurrence, is a matter of great concern to the practical planter, as upon it largely depends the arrangement of his planting programme. It may also prove a determining factor in respect of crop yields, but the rate of leaf production must not be overlooked in this connection.

SOIL AND CLIMATIC CONDITIONS.

The sisal plant will thrive in most well-drained soils in the low country dry zone, although it does not appear to like the red soil to be found in the Jaffna peninsula.

Soil subject to overflow or liable to remain saturated for any length of time is unsuitable.

Good results may be expected when the soil is not too rich in humus and where there is a well-defined dry period with plenty of sunshine, although a certain amount of humidity brought about by dews and showers of rain during this period will act beneficially. It is a generally accepted fact that the richer the soil the shorter the life of the plant, and also that plants which grow rapidly, i.e., on rich moist soils, produce longer leaves which, however, contain a smaller percentage of fibre.

This fact should be borne in mind when considering localities suitable for sisal planting, in view of problems which arise in connection with transport of leaf and the after-cultivation of old sisal fields.

PESTS AND DISEASES.

On July 30, 1925, the Government Entomologist stated that no reports had been received of any attack by *insects* on sisal in Ceylon.

The Government Mycologist stated that there is no Ceylon record of *disease* on sisal.

Cattle and goats are partial to the leaves.

At Mahailuppallama *wild pigs* have been found to cause considerable damage by eating out the central undeveloped leaves of half-grown plants.

At Ambalantota *porcupines*, which gnaw right into the heart of even mature plants, have been very destructive.

PROPAGATION—BULBILS *v.* SUCKERS.

There are two practical methods of propagating the plant: (a) By means of bulbils; (b) by means of suckers.

Bulbils are generally used for starting a plantation, as they are more easily obtainable in large quantities.

Previous to planting out in the field they should be kept in nurseries 9 in. apart (in rows 18 in. apart) for about one year, until they attain a height of 18 in.; while in the nursery they must be carefully cultivated, watered, and weeded.

When an estate is being developed, and if suckers have to be used, they should be set 12 in. apart in rows (24 in. apart in a nursery) and given the same treatment as for bulbils.

It is an advantage that they can be planted out in the field earlier than in the case of bulbils, but they may "pole" earlier.

The transplanting operation is easily and quickly effected into small holes prepared in advance, care being taken that the bulb is no more than partly covered with earth. As regards planting distances, there is much difference of opinion as to the best spacing; it will naturally depend upon the size to which plants will grow in the particular soil and climate.

The spacing adopted at the Experiment Station, Anuradhapura, North-Central Province, is 6 ft. by 8 ft., which gives 908 plants per acre, while at Mahailuppallama it is 8 ft. by 8 ft., giving 681 plants per acre.

This may be considered to be a satisfactory

spacing, although some difficulty has been experienced by the pole-cutting and leaf-harvesting coolies moving about the plantation.

When jungle land is prepared for sisal planting in Ceylon, removal of stumps will be unnecessary, as ploughing and other mechanical cultivation is impracticable for any length of time ; at the same time it is essential that attention be given to systematic weeding and also to killing or uprooting of jungle growth, which tends to spring up during the first two years.

A weed-smothering crop such as boga medeloa, which grows readily in the North-Central Province, may be grown between the rows of plants with advantage, but it will probably be necessary for the boga to be topped, as shade has a bad effect upon the sisal leaf, causing a diminution in the fibre content. It is for this reason that the planting of sisal as a catch crop in coconut plantations is not advised. Sisal should always be grown as a pure plantation,

Kurakkan and also cotton may be grown as catch crops in young sisal plantations.

The removal of all suckers which may develop during the first two years is recommended.

This was attempted at both Mahailuppallama and Anuradhapura Experiment Stations, but was found to be impracticable owing to labour difficulties, with the result that trouble has been experienced while harvesting the leaf owing to the vigorous crop of suckers clustered round the plants ; it is probable also that the full development of the plants has been retarded.

It is considered advisable, when the pole or flowering stem attains a height of four feet, to remove it at a point just above the base of the upper leaves, as the fibre-producing power of the plant will thereby be prolonged.

HARVESTING.

The time required for a plantation to reach the producing stage depends upon the type of plant, the quality of the land, and the cultivation given, and is said to vary in other countries from five to twelve years.

In Ceylon it may be put at between three and a half and four and a half years.

At Mahailuppallama Experiment Station.—In April, 1913, with reference to the original 4-acre plantation for which bulbils were used, the Manager's report for April, 1913, reads as follows:—

"The plants are now ready for the first cutting of leaves, i.e., three and a half years from planting. A trial cutting on a small scale has shown that 40 leaves per plant are ready for cutting, and that the yield from 1,000 leaves is approximately 40 lb. fibre. The leaves average 4 ft. 9 in. in length and $1\frac{3}{4}$ lb. in weight."

At the Dry Zone Experiment Station, Anuradhapura, where the plantation originated from suckers, harvesting did not begin before the early part of the fourth year, although had the fibre-extracting machine been in position cropping would have begun earlier.

The leaves which are ready for cutting tend to extend laterally at right angles to the trunk. The cutting of mature leaves should not be unduly delayed, or there will be a deterioration in the quality and a loss of fibre.

Similarly, care should be taken that immature leaves are not cut; their removal will weaken the plant. Leaves resting at a more acute angle than 45° with the vertical should always be left.

One, or preferably two, cuttings per season (period, January to September), should give an average of 40 leaves per plant. There is little, if any, data at present available as to the life of a plantation in Ceylon.

Experience both at Mahailuppallama and Anuradhapura indicates that seven to eight years is the probable life of a sisal crop in the north dry zone.

The age at which the poling takes place is the governing factor, and it is considered by some that undue delay in harvesting the first crop of leaf will bring about early poling.

The Harvesting Operation.—A heavy knife with a hooked end like a pruning knife, but with a long handle some 18 inches in length, is a most effective weapon, and with it a good cooly can cut out 3,000 leaves per day.

The leaves should be graded, tied into bundles, carried to carts, and transported to the factory without delay. A double-bullock cart over an average track will carry 1,500 to 2,000 leaves.

EXTRACTION OF FIBRE AND AFTER-TREATMENT.

Machinery (of which there are many types, all more or less costly) is essential for this purpose.

Any delay in passing the harvested leaf through the decorticator is bad and should certainly not exceed twenty-four hours.

The resulting fibre produced must be quickly but thoroughly washed in clean water and then hung out in the sun to dry. When quite dry, the fibre should be brushed, either by means of a brushing machine or by hand—the former method is to be preferred.

Brushing cleans the fibre and imparts a better finish. The fibre is then carefully graded and finally baled by means of a mechanical or an hydraulic press.

The dimensions of a satisfactory type of bale for export are as follows : length, 47 in. ; breadth, 15 in. ; depth, 18 in. Such a bale would weigh 400 lb.

The bale should be secured with wire bands and may be wrapped in jute hessian.

During the operation of fibre extraction and brushing there is always a certain amount of loss which is recoverable in the form of tow.

At the trials which have been made at the Dry Zone Experiment Station, Anuradhapura, the proportion of tow to dry fibre produced has been as follows : 12 cwt. of the former to 16 tons of the latter.

YIELDS.

The yield of fibre per acre will of course depend upon the spacing of the plants in the plantation, the local conditions, the type of sisal grown, &c.

As regards the yield of fibre per plant, each plant should during its lifetime produce anything from 100 to 200 leaves.

The fibre content will vary from $2\frac{1}{2}$ to 4 per cent. of the weight of the fresh leaf, variations are both individual and seasonal. From this it follows that each plant should yield an average of 8 lb. of fibre during its life.

DATA FROM THE EXPERIMENT STATION, ANURADHAPURA.

Fibre content for the cropping season of 1924, i.e., April to September inclusive, 2.6 per cent.

Fibre content for the cropping season of 1925, i.e., January to May inclusive, 2.8 per cent.

The average weight of a matured leaf, 1.4 lb.

The number of leaves required for one ton dry fibre, 62,500 leaves.

The average number of leaves harvested per plant per annum, 44 leaves.

Weight of fibre per acre per annum, 0.5 to 0.6 tons.

Estimated extent of cropping period, four to five years.

DISPOSAL OF THE WASTE.

The economical and satisfactory disposal of the very large quantity of leaf refuse produced in the extraction of the fibre is a problem of some complexity.

The utilization of the waste for the manufacture of paper, alcohol, fuel, or manures is not as yet a commercial proposition.

Tentative trials have been made at the Dry Zone Experiment Station, as to the value of decomposed waste as a manure for paddy; but results were not conclusive.

Large quantities of the fresh waste applied to the soil in a coconut plantation has had a most injurious effect upon the palms, and it is safe to say that the fresh waste, owing to its intense acidity, should never be dumped in close proximity to plantations or crops of any sort.

The following is a report of the Ceylon Government Agricultural Chemist on the samples of fresh and well-decomposed refuse sent from the Dry Zone Experiment Station for analysis:—

SISAL REFUSE ANALYSIS.

<i>Sample A.</i>	<i>Sample B.</i>
Fresh refuse.	Well decomposed refuse.

Sample A is the fresh refuse as turned out by the machine. The acid content of the sample is very high indeed—about 10 per cent. of the dry matter. It cannot therefore be applied to the soil until it is well rotted and thoroughly dried, during which time decomposition and neutralization of the acids will have taken place. The sample contains over five times its dry weight of water and acids. The percentage of acids is comparable to that in silage. The percentage of nitrogen (2.13 per cent.) is higher in this sample than in the other sample, as the drying and rotting

will have led to some decomposition of the nitrogenous products present in the moist material.

In sample B, which is the refuse after decomposition, the nitrogen content is 1·87 per cent., so that one ton of this material will contain 475 lb. of nitrogen.

There is a slight acidity which can be rectified by the addition of a little lime with the refuse before it is applied to the soil. The ash is rich in potash and phosphoric acid, amounting to 17·6 per cent. and 9·4 per cent. respectively. One ton of dry matter will therefore contain about 170 lb. potash and 90 lb. phosphoric acid.

The refuse in the dried and decomposed state ought to be of some value as a manure for poor soils, lacking in organic matter and mineral salts. It would be advisable, however, to apply it to the soil with the addition of lime some time before a crop is sown.

SISAL REFUSE ANALYSIS.

	Sample A Per cent.	Sample B Per cent.
Moisture and volatile subs. (on dry matter)	50·8*	8·69
Dry matter	—	91·31
Total ash	43·5	43·5
Fine ash	34·8	34·8
Sand and silica	8·7	8·7
Nitrogen	2·13	1·87

Ash Analysis.

Potash	17·6	17·6
Phosphoric acid	9·4	9·4
Acid (cal. on dry matter)	—	—
Non-volatile as (lactic acid)	10·15	0·29
Volatile (acetic acid)	0·2	—

* This is as printed. Should it have been 5·08 per cent.?—H.H.S.

With regard to sisal refuse, Adco Ltd. tell me that for three or four years they have had inquiries from different people interested in this waste. The first sample to be tested went down in the "incubator" to a wet sludge which could be poured from a bottle,

some of the resistant fibres floating on the liquor. Such a manure could be, and would have to be, piped on to the cultivated soil. More recently the firm had another sample consisting almost entirely of waste fibre, which they knew by previous experience to be very resistant. To give the microbes something to start on, the waste sisal was mixed with 50 per cent. wheat chaff, and the mixture—to a surprising degree—made quite a good manure, containing 86 per cent. moisture, 11 per cent. organic matter and 3 per cent. ash. The organic matter contained 5.05 per cent. nitrogen, and such a material could easily be carted, and is, in fact, a rather better analysis than the average made from wheat straw alone. There would, of course, also be some phosphate and potash (see pp. 114 and elsewhere), but these were not estimated.

As this mixture of sisal and straw went so well, another test was made with sisal (from East Africa) alone. The material rotted quite satisfactorily, but the analysis has not yet been received, and so far as can be judged without inspecting the actual operations overseas, the soft pulp must be treated like sewage and purified by irrigation, whilst the residual fibre can certainly be converted into useful organic manure with Adco. Whether it would pay to do so—avoiding the cost of removing the sludge, and putting up with the nuisance of, if not the danger from it on the one hand, and having large quantities of fertilizer material which, of course, still has to be transported to desired localities—remains to be proved.

AFTER-TREATMENT OF OLD PLANTATIONS.

As the life of a sisal plantation is a comparatively short one, the economical treatment of such land is a matter of some importance.

The land may either be left fallow for a while, utilized for other crops, or recropped again with sisal. If the land is to be abandoned, fallowed, or used for other crops, it is very necessary that effective steps be taken for the eradication of all suckers, or an impenetrable and valueless thicket of sisal will soon possess the ground.

If the land is to be recropped again with sisal, strong healthy suckers may be planted (in the space between every 4 old plants), during the rainy season before what is reckoned to be the last cropping period.

The stumps or butts of the old sisal plants can be uprooted as soon as the remaining leaves have been harvested, but their removal and ultimate destruction is difficult.

The eradication, as far as possible, of all suckers at this time is most important.

CONCLUSION.

(a) Large scale operations for the cultivation of sisal appear to be economically sound, owing to the heavy outlay required for the provision of the necessary fibre-extracting machinery; and, for company operations, a planting area of not less than 3,500 acres would be required. Such an area would have to be divided into seven sections, one section of which would be planted each year, so as to ensure a regular supply of leaf for the factory.

The factory, which should, of course, be centrally situated, thus facilitating easy transport of the leaf from all sections of the estate, must be provided with a regular and clean water supply for washing the fibre.

(b) Similar operations on a much smaller scale and with Government-owned and controlled factories in the first instance, might successfully be introduced in certain localities, where the villagers could cultivate

STATEMENT OF EXPENSES INCURRED IN EXTRACTION OF SISAL FIBRE, 1926-27. (AVERAGE PER COOLIE PER DAY, 73 CENTS.)

Items of work	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	August	Sept.	Total	Expenditure
Mechanic ...	15	17	9	24	24	7	16	22	27	16	13½	—	190½	Rs. 6½
Extraction (contract) ...	21'80	14'88	11'60	28'58	30'72	4'00	10'34	34'49	46'26	15'29	22'66	—	—	Cts. 72
Ditto ...	—	3	—	½	2	—	1	1	—	—	—	—	—	5 47½
Harvesting sisal leaves ...	33½	31	20	45	49½	15	24½	48	63½	24	30	—	384	280 32
Carrying and carrying sisal leaves ...	49	56	39	87	91	28½	38	100½	127	43	58½	—	717½	523 77½
Removing sisal refuse ...	21½	38½	12	45	52	13	13½	36½	52½	26½	23	—	334	243 82
Pumping water ...	12	11½	6	20	17	6½	5½	17½	24½	9	12½	—	142	103 66
Supp'ying leaves ...	11	9	7	16	15	4	6	9½	—	—	—	—	77½	56 57½
Washing sisal fibre ...	64	58	41	99½	80	29½	33½	101	119½	45½	64	—	735½	536 91½
Making rope and baling ...	—	9	32	—	44	3	—	—	1	30½	6	6	137½	100 37½
Sorting fibre (contract) ...	—	35'66	—	29'79	36'68	—	—	—	42'07	38'77	24'79	1'64	—	209 40
Ditto ...	—	12½	—	—	—	—	—	—	—	—	—	—	12½	9 12½
Transporting fibre balls ...	—	—	—	—	—	18½	—	—	—	—	—	—	18½	13 50½
Cleaning engine ...	5	—	—	—	—	—	—	—	—	—	—	—	5	3 65
Filling water-cooling tank ...	3½	—	—	—	—	—	—	—	—	—	—	—	3½	2 55½
													2,765½	2,468 93½

	Rs.	Tons	Cwt.	Qrs.	Lbs.
Liquid fuel ... 250 gallons at 28 cts. per gallon	70'00	10	2	0	21
Machine oil ... 24 " 1'50 Rs. " "	36'00				
Kerosine oil ... 18 " 1'20 " " "	21'60				
Cotton waste ... 12 lb. 27 cts. per lb.	3'24				
Grease ... 13 " 22 " " "	2'87				
Jute hessian ... 400 yds. 30 " " yd.	120'00				
Total ...	253'70				
Cost of labour ...	2,468'93½				
Total Expenditure	Rs. 2,722'63				

(Cost per acre ton of fibre = Rs. 269'32.)

Rs. 3,588'82
" 2,722'64
Rs. 866'18

the crop and bring their leaf to the central factory. The introduction of sisal, as a crop for Village Agriculture on lines such as these, and as a means of improving the economic condition of villagers in the Dry Zone, would appear to have distinct possibilities.

REFERENCES.

"Sisal Economics," by Major L. A. Notcutt, A.R.S.M., D.I.C.
Bulletins of the Imperial Institute.

Reports and Records of the Department of Agriculture.
Ceylon.

CHAPTER IV.

KENYA AND EAST AFRICA.

THE industry in Kenya had many vicissitudes at first, at least so we were told in 1924. Before the War the price of their sisal averaged about £29 per ton, and at that price, with the lower cost of machinery, lower wages and salaries, lower land values, &c., its production could pay.

During the War much harm was done to the reputation of the industry, if not the industry itself, for the War caused its votaries to expect so much, only to be disappointed. This was due to the glitter of the controlled price—£99 per ton during the War, a quite unnecessarily high price (as the Kenya Guide to Wembley, p. 79, told us), in spite of the cost of ocean transport of over £25 per ton. This high price led to somewhat extravagant ideas in London as to what could be done with sisal, and, on the estates, led to extravagant methods of production. Then came the slump and disillusionment in 1920-1921, when freights fell slowly, but prices, especially in 1920, came tumbling down, and so did the profits. Properly managed, however, if run on a sufficiently large scale, with fair rates of pay for the staff—rates, that is, which are attractive without being extravagant—sisal still showed a profit, as surely Major Notcutt showed in his book "Sisal Economics." It is, however, an industry which needs economical management, the same as does cane-sugar production. Do not allow odd leaves which drop off the trollies on the way to the factories to remain on

the ground. Remember the fibre content in them—which in the aggregate mounts up to an astonishing degree—comes out of your profit, not out of current expenses.

Whatever the area under sisal in Kenya Colony may be when this book is published, up to now it has been astonishing how that area has expanded. This being the case, it is not surprising to see handbooks are provided with slips telling you that the area under sisal put at 60,000 acres in these books was already at 70,000 with signs of a further increase, whilst the latest production return was 17,000 tons, worth £600,000.

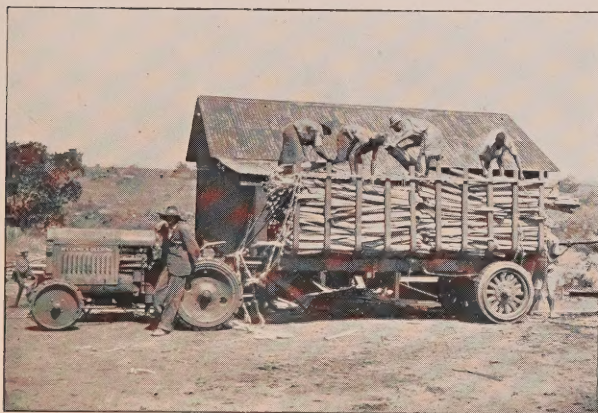
In 1927 the outturn of sisal, so the Annual Report of the Department of Agriculture (p. 13) for that year tells us, was much increased over 1926, but owing to the fall in prices the value of the fibre exported only amounted to £468,974 for the 15,855 tons of fibre produced, against £579,499 for 14,918 tons in 1926. The total area planted on July 31, 1927, was 71,213 acres, of which 40,751 acres were over three years old and therefore ready for cutting. The increase in area for 1927 was 11,016 acres, or 18·30 per cent. over the previous year. Well-wishers for the industry are energetically pursuing investigations into methods and systems with a view to lowering working costs and increasing acreage outputs. This is the real reason for the appearance of this book. Do not run after planting fresh lands, but get more sisal at least cost from the areas at present planted.

It is usually considered that 2,000 acres of arable land are necessary for a one-unit plantation in order to plant 250 acres annually with an eight-year rotation. To this should be added about 1,000 acres for grazing, &c. In 1924 we were told that suitable sisal land could probably have been bought at a very reasonable cost. As we are dealing with what is, not with what

PLATE V.



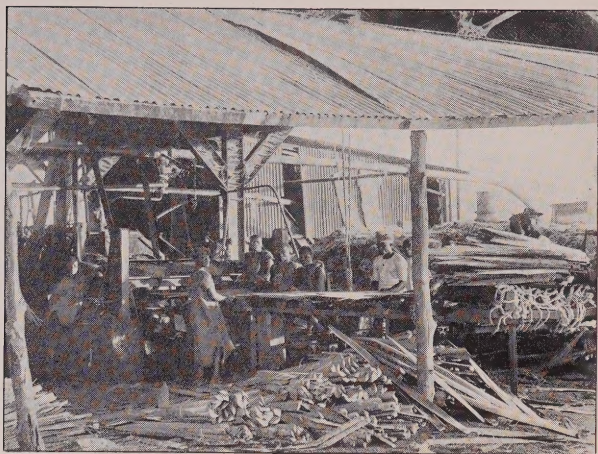
Cultivating young sisal, Kenya.



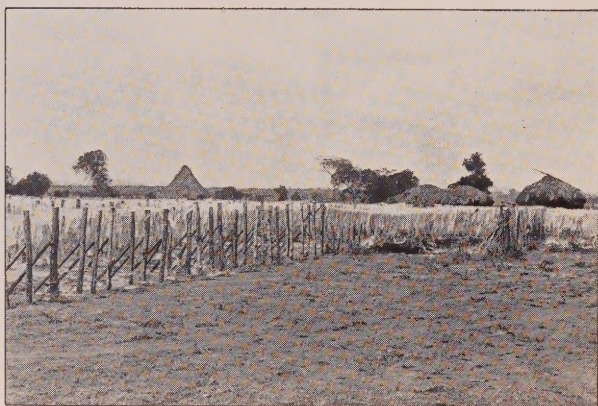
By courtesy

S. A. Sisal Growers' Asso.

Transport of sisal by tractor.



Decorticator at work, Kenya.



By courtesy

Dept. Agri., Nairobi.

Sisal drying, Kenya.

was, the price mentioned need not be given, but how do present costs compare with the following?—

A factory completely equipped with new machinery, the necessary rails and trucks, &c., can be erected for about £8,000 (for the 2,000 acres mentioned above). Add to this another £6,000 for planting 1,000 acres in four years, when production on the first 250 acres should be due. During these four years returns from catch crops could be expected. From the above figures, £20,000 was considered (in 1924) to be sufficient capital to start such a sisal plantation, i.e., £10 an acre on the 2,000 acres. How does this compare with ideas in 1929? Again how does the estimate drawn up in October, 1925, and given in full at the end of this section, compare with present costs of land, labour, machinery, &c.? Which items are higher and which lower? As regards the machinery, it is to be hoped that the engineers can help in one or two of the items.

On account of the need of running "large" for sisal production, as is done in Mexico, the industry is undoubtedly one which is adapted to control and management under farming company conditions, with considerable capital and capable and experienced control. With these, the purchase and development of areas for sisal plantations should still show a profit to the shareholders, but—remembering company promotion fairy tales in the past (especially in connection with coconuts)—before you put down your money, make sure that in return the directors and promoters possess a genuine knowledge of sisal and not merely of company promotion and of telling the public a pretty story in an attractive manner.

CULTIVATION IN KENYA.

Published accounts point out that in the old-time German East Africa and along the coast in Kenya

very little cultivation was done before planting. Usually the land is only roughly cleared, and whatever method is used it must meet the requirements of the country where it is difficult to keep oxen, also because on the coral land no other method is possible. One wonders how it would pay on such soil to use explosives, with discretion, to break up the ground. Would it be necessary? Would it pay to do so?

In the Highlands, things seem different. There the land is thoroughly well ploughed and harrowed, tractors being largely used. Planting, we are told, can be done either in the rains or during the dry weather and need not be done with great care except as to alignment, as the plants are very hardy. Regarding the use of suckers or bulbils, either can be used; but whilst suckers can be planted at stake, i.e., out in the fields, right off, bulbils are passed out, as a rule, through the nursery, being too small to plant out as and when they fall from the pole.

Spacing is said to vary a good deal, with 48 square ft. as about the average to each plant in the Highlands, and 32 square ft. at the Coast. The first cutting generally takes place at about three and a half years old in the Highlands and at under three years at the Coast. During the first two years after planting, catch crops such as maize, beans, &c., can be grown with profit between the plants, whilst at the same time they help to keep the land clean.

Another account tells you that in the Highlands the land is thoroughly well ploughed, cross-ploughed and harrowed. A number of double-engine ploughing sets have been imported, which prepare the land rapidly and perfectly. With harvesting, accounts vary, because the training, the will and the ability of the labour, men or women, who cut and gather the leaves vary also. In the days of indentured East

Indian coolie labour for sugar estates, payment was made by the "task," but critics of that system claimed that exceptional men were chosen to "set the pace," so that whilst they got the full 12 or 15 cents for the "job," the less able ones took 50 per cent. and even 100 per cent. more time, so that some only got half the wage of others, and disputes, ill-will, ill-treatment and revolts occurred which never should have been caused. The modern method of management by psychology, that is to say to adapt the worker to the job or the job to the worker, if you wish to get 100 per cent. or even 80 per cent. efficiency out of your labour forces, can be brought to play with the greatest advantage on any tropical estate, and so, although men may smile at the word—psychology—substitute the more common-place expression, tact, and then make use of it. Then and then only will you get from 1,000 up to 2,000 leaves a day from the men according to their experience and 800 leaves or more from the women, always supposing the plants are in full bearing and the workers enjoy good health. Thus it comes about that good estate managers have to see that the health of the staff is good, if only for reasons of £ s. d.

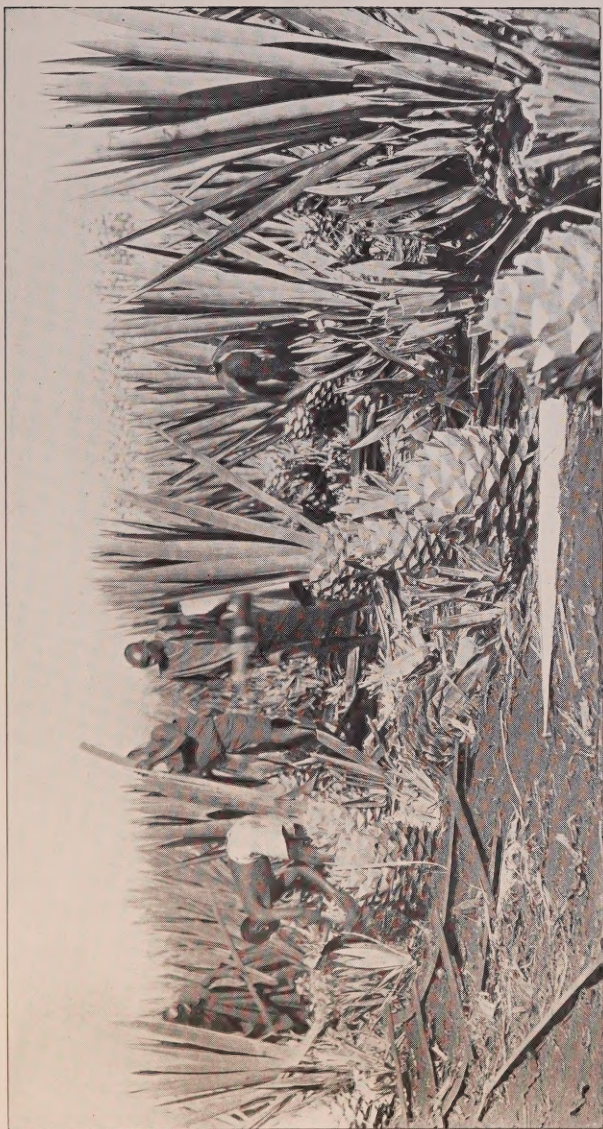
REGARDING THE FACTORY.

All accounts agree that the factory should be situated as near the middle of the estate or area to be served as possible. It should be, as already suggested, in such a position as to allow the trucks loaded with leaves to travel to it downhill, having regard also to the source of the water supply. At the same time, there should be a good fall from the factory into a convenient gully so that the water-borne waste may be easily disposed of without creating a nuisance until steps can be taken to utilize it to advantage instead of having to dispose of it at expense.

In the decorticators, the skin and fleshy parts of the leaf are described as being removed from the fibres by steel knives bolted to revolving drums as the leaf passes over concave saddle plates. During this operation, water flows through the machine and washes the fibre white as it is being decorticated. The water also washes all the waste matter down a drain, generally made of wood, into an adjacent gully, and it is the contents of this gully which the layer-out of the estate and its factory has to see are run off, somewhere and somehow, in a way that will not give rise to ill-health and ill-will.

This reminds one that after being washed the fibre is dried and wire sometimes is used, although as a rule it is too costly. Is there not the liability also of rust to stain the fibre, be the wire ever so well galvanized at the start, or can some non-rusting metal be used at a cost which can be afforded? Elsewhere in this book drying by centrifugals and band conveyors has been fully discussed, showing how the use of outdoor drying can be reduced to a minimum, especially at first when the fibre is so very wet. Home-made supports can be and of course are freely used, i e., the sisal poles for instance, or roughly made ropes from the fibre itself.

With regard to the harvesting, at seventy leaves per plant for the first cutting, which can be obtained, according to Rutherford, a yield of about one ton of fibre is obtainable. This seems to the writer over-optimistic, unless on a picked estate. A fair average, after the first cutting of twenty to twenty-five leaves per plant, is for 10 cwt. per acre per annum, although more at times can be looked for. Rutherford sounds safe when he talks of $3\frac{1}{2}$ tons of fibre as the total yield during the lifetime of an acre of sisal. How is this quantity arrived at? Can we say 1 ton for the first year and an average of half a ton for five years more per acre?



By courtesy

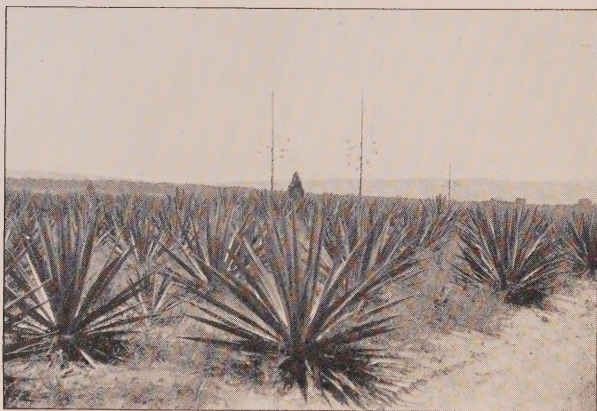
Cropping sisal in Kenya.

Dept. Agric., Nairobi

PLATE VIII.



Cropping sisal on the Gold Coast.
Note the vigorous growth.



By courtesy

Dept. Agri., Gold Coast.

Sisal starting to "pole," on the Gold Coast.

PRODUCTION IN KENYA.

SOME ESTIMATES.

For permission to reproduce the figures on the following pages, we are indebted to the editor of *East Africa*. The article is by Mr. Campbell B. Hausburg, who contributed to that journal's special number entitled "Settlement in East Africa," published in 1927.

General Notes.—Both the capital employed and the operating and transporting costs depend upon the district in which the sisal is grown, the character of the climate and soil, the local rate of wages for native labour, the conditions affecting water supply and the nature of the machinery employed, whether steam, oil or gas engines are used, or water power, or electric power supply is available.

The costing set out below is based upon an electric power supply being available, and in regard to other conditions affecting the cost of production average costs have been estimated.

In the Highlands there is now, or will be very shortly, a large electric power supply at high pressure available for driving the machinery in sisal factories.

Estimates of cost of plant and operation are given below under the following headings:—

Capital.—Capital employed in land; in development; in factory and factory machinery; in estate machinery and equipment, including oxen; in water supply plant; in buildings; in general capital expenditure.

Operating.—Cost of gathering the crop and transporting to factory; operating the factory; re-planting cut-out areas; transport from factory to railhead; rail freight to coast; handling at coast; ocean freight and insurance; marketing the produce.

Management and Administration.—Depreciation, salaries, rents, &c.

ESTIMATES—WITHOUT GUARANTEE, FOR INFORMATION
AND COMPARISON ONLY.

Capital Expenditure.

	£	s.	d.
<i>Land</i> , including, say, 2,500 acres of soil suitable for sisal cultivation and sufficient grazing area for cattle, sufficient area for growing maize or other food crops and timber, also sufficient area for houses, stores, &c., say, 4,000 acres at £4 an acre	16,000	0	0

Development—

Initial development, including clearing, ploughing, planting, weeding and cultivating, say, 2,000 acres at £12 10s. per acre (including a proportion of indirect or overhead charges) (See note below)	25,000	0	0
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Note.—By “initial” development is meant the first clearing, ploughing, planting, &c., of the 2,000 acres. This will be gradual, about 300 acres being planted the first year and 250 acres per year subsequently.

As the whole planted area will not at any one time be fully developed, the capital employed will be reduced in amount accordingly. On one estate planted up for an output of 750 tons of fibre per annum the capital employed in development last year was only about £12,500.

Factory—

The cost of erecting and equipping the factory will be incurred during the third year after the first planting.

Steel shed and foundations ...	£750	0	0
1 Decorticator and spares ...	1,500	0	0
100 h.p. electric motor and switch-gear	290	0	0
Step-down transformer and switch-gear	250	0	0
Baling press (hydraulic) ...	650	0	0
Water supply pipes and fittings, say	50	0	0
Brushing machinery	500	0	0
Tools	250	0	0
Mealie Mill	50	0	0
Millwrighting and Belting	250	0	0
Telephone and lighting installation	150	0	0

	£	s.	d.	£	s.	d.
Outward freight and Insurance						
on Machinery, &c.	300	0	0			
Erection, say	1,000	0	0			
Sundries, say	500	0	0	6,490	0	0

Note.—Only one decorticator is provided for in above estimate, but it is advisable, if capital resources allow of it, to instal a second decorticator, so that one machine can always be kept in repair and adjustment.

Estate Machinery and Equipment—

5 Miles of rail track (c.i.f., Kilindini)	1,690	0	0
60 Sisal trucks at £22 10s. (f.o.r.)	1,350	0	0
Agricultural machinery, say ...	1,000	0	0
*Oxen, say	1,000	0	0

**Note.*—On sisal plantations in the Highlands it may be found advisable to supplement oxen by tractors. No allowance is made for this. It must be remembered that periods occur when tractors cannot be used owing to the condition of the ground.

Outward freight	200	0	0
			5,240 0 0

Water Supply Plant—

Pump and electric motor ...	125	0	0
Step-down transformer and switch-gear	120	0	0
Pump house and foundations ...	75	0	0
Pipe line to factory, say ...	400	0	0
			720 0 0

Buildings—

Manager's house and equipment	2,000	0	0
Engineer's and other white employees' house... ..	1,000	0	0
Stores, sheds and equipment ...	1,500	0	0
Go-down at rail head, road and bridges, say	500	0	0
Native huts, say	250	0	0
			5,250 0 0

General Capital Expenditure—

Lawyers, accountants, consulting engineers and general administration and formation charges during the period before cropping and producing commences, say	...	...	5,000 0 0
---	-----	-----	-----------

<i>Total Capital Expenditure</i>			<u>£63,700 0 0</u>
----------------------------------	--	--	--------------------

Operating Expenditure.

Cost of gathering Crop and transporting to Factory—

	Cost per ton of fibre produced
Cutting	£1 12 0
Laying and relaying rail track...	0 13 6
Trucking leaves to factory ...	1 12 6
Repairs to rail track and trucks,	
say	1 0 0
Oil, grease and sundry stores, say	0 5 0
Scotch carts and oxen	0 5 0
Supervision	0 10 0
	£5 18 0

Cost of Operating Factory—

Decorticating	1 4 0
Brushing	0 6 6
Baling	0 5 6
Repairs and renewals to	
machinery, say	1 0 0
Oil and grease and sundry stores	0 5 0
Supervision	1 10 0
Electric power supply	2 0 0
Sundry expenditure	0 10 0
	7 1 0

Cost of Replanting Cut Out Areas—

The cost of replanting, including stumping, suckering, ploughing, planting, weeding and cultivating may be taken at £10 an acre, which on the basis of three tons of fibre produced per acre amounts per ton of fibre produced to 3 6 8

Note.—The above estimate does not include any allowance for indirect or establishment charges. It is taken for granted that an estate operating on a continuing and regular cycle will plant an equal area to that which is cut out. In regard to initial development, it is, of course, right and proper to charge a proportion of the indirect charges to its cost.

Also note that three tons of fibre are looked for per acre; surely no estimate on a commercial basis should rely on such great expectations.

Cost of Transporting from Factory to Rail Head—

Say 10 miles at rs. 6d. per ton	
mile	0 15 0

Cost of Rail Freight to Coast—

From the Thika district 30s. per ton weight baled at 80 cubic feet to the ton	£1 10 0
---	---------

Cost of Handling at Coast—

Present rate for bales compressed to 80 cubic feet to the ton, about	1 0 0
--	-------

Cost of Ocean Freight and Insurance—

Freight 40s. per ton weight or 80s. per ton measurement if baled at 80 cubic feet to the ton, less 10 per cent. rebated and Marine Insurance, say 7s. per ton	3 19 0
---	--------

Cost of Marketing the Fibre—

Say, 2 per cent. on £45 per ton	0 18 0
---	--------

Management and Administration—

Salaries, Management, Accountant and Secretary	£2 0 0
Directors' fees, say	0 10 0
Rents, say	0 2 6
Depreciation	2 0 0
	4 12 6

General expenditure under the headings of: General Labour, Stationery, Sundry Stores, Motor Vehicles, Medical Stores and Fees, General Transport on Estate, Travelling Expenses, Reserve for Passages of Employees, Registration Fees, Go-down Expenses at Rail-head and Coast, Insurance, London Agent, Audit Fees, Legal Expenses, Stamps and Cables, Visiting Inspector, Subscriptions, &c., &c., say	1 0 0
Allowances for contingencies, say	1 0 0

All-in cost per ton of fibre produced and transported

<i>c.i.f. London or Continental Port</i>	<u>£31 0 2</u>
--	----------------

Since compiling the above memorandum on sisal planting, many estimates as to the cost per acre for ploughing and cross-harrowing with a double set of

Fowler's steam tackle, and by other means, have been mentioned with and without including the cost of fuel and water. In many cases the figures ran too high to be reliable, the circumstances being exceptional, and in *all cases* great caution was needed to arrive at accurate figures.

As regards bullocks, 34s. (thirty-four shillings) is the figure given for first ploughing, cross-ploughing and harrowing one acre of land.

During the last four months for which returns have been received, 279 acres had been broken at a cost of 10'61s. per acre with all costs, but no depreciation.

In one particular month 92 acres were ploughed at an average cost of 9'90s. per acre. There were 22 working days in that month; and the consumption of stores, &c., was 280 gallons kerosene, 16 gallons petrol, 12 gallons lubricating oil, 10 lb. grease. The cost of labour was 230s.

* * * *

Every visitor to Nairobi, F. S. Joelson tells us, in pp. 108 and 109 of that most useful book of his, "Eastern Africa To-day," will remember old humped-back Donyo Sabuk, a corruption of the Masai name, Ol Doinyo Sapuk, meaning "The Mountain Stretching up to Heaven," which it does to the height of some 7,200 feet, whilst its base must cover some 30,000 acres, good for buffalo but too steep for cultivation. This familiar landmark stands in the midst of an area originally opened up in 1908 by one of Kenya's most prominent pioneers, the late Sir Northrup MacMillan, who, by his own desire, lies buried on the summit of the mount. The chief products around are coffee and sisal, some 1,360 acres being under *arabica* coffee.

Sir Northrup pioneered the growing of sisal, of which there are about 3,500 acres with an output of 700 tons in 1927. The largest sisal properties are those of Lady MacMillan, the B.E.A. Fibre and Industrial Company and the Earl of Craven.

TANGANYIKA.

If the readers of this book find that as much space has not been devoted to this Territory as might have been looked for, considering its importance as a producing centre, they can rest comforted in the knowledge that it is this very assured position of Tanganyika as a producer which caused the writer to cut short her allowance. One cannot want more than to be happy—surely this Colony can well be described as entirely happy in its flourishing sisal industry; so best leave it alone, especially as every present grower of sisal, outside Mexico, has dared me to encourage fresh men to come in and plant. Were I to say what I really thought of Tanganyika (or of Kenya too if it comes to that) as a producing centre, there is no saying what might happen, so one feels it is best to leave well, i.e., Tanganyika Territory, alone except to say that my notes speak of her as having exported 36,186 tons of sisal in 1928, being a healthy increase over the 33,012 tons which left in 1927. In 1913 (under Germany) the export was 20,834 tons. In 1921, 7,932 tons, which jumped up to 10,224 in 1922, 12,845 in 1923, 18,428 in 1924. Since then the progress has been wonderful.

The British Empire Exhibition at Wembley begins to fade somewhat in our memories, wonderful as it was, but in these days no one need be ashamed of saying such a thing, as so much fresh matter comes along to be absorbed by our already over-worked brains—if we are workers—that no one can expect to retain as vivid a remembrance of five years back as one would like. Out of that great event however, Tanganyika still stands forth prominently because of the truly wonderful Handbook published in 1924 concerning the Territory, its lands, people, history, present-day industries and future prospects. At the

time I thought much of the information given, to-day the book seems even more useful to refer to than was the case at the time of its publication. Who was responsible for its being we are not told, but whoever he was, or they were, mentally I still raise my hat to them when I dive into the book. Sisal is discussed thereon, pp. 79-80, as follows. [Does the same information hold good to-day?]

The main problem in several localities, in regard to sisal production, is the obtaining of a sufficient supply of water for preparing it for market. A matter that requires the attention of planters is the treatment of land on which sisal growing has ceased for the time being, i.e., whether such land should remain in rough fallow or whether the benefits of fallowing should be combined with those of the cultivation of other crops of value but not likely to cause soil exhaustion? The latter scheme would help to pay for the clearing of the land of sisal plants remaining, a task both difficult and expensive, although the cost is partly met at present by the exploitation of old, remaining sisal. Some planters appear to consider a long fallowing of the land under light timber to be useful. Another subject worthy of attention is the growing of cotton (in suitable localities) as an intermediate crop with young sisal. This has been tried to a useful extent and the present indications are those of success. As regards sisal generally, its simple methods of growing and preparation for market, and its comparative freedom from harmful enemies, leave little to be done at present in the direction of expert inquiry and advice for the crop, although *the question of the utilization of sisal refuse requires urgent investigation.*

CHAPTER V

MALAYA

IN the last departmental report to hand, i.e. for 1927, Mr. F. W. South, as acting Secretary for Agriculture, included the following paragraphs on the work done by the Agricultural Department of the Federated Malay States in connection with fibres. There we were told :—

SISAL HEMP.—The possibility of the commercial production of this crop locally has attracted attention during the year. An experiment was started at the Government Experimental Plantation, Serdang, with the object of ascertaining the optimum interval that should elapse between successive harvests of leaves, with reference both to the yield of dry fibre, and to its quality and tensile strength. Another experiment in progress is intended to test the relative values of bulbils and suckers when used as planting material.

MAURITIUS HEMP.—A crop of leaves was being harvested at the end of the year, and about $2\frac{1}{2}$ tons of fibre, forming part of a trial consignment, had been baled in readiness for shipment to London.

TERAP BAST (*Artocarpus Künstleri*).—Work on this fibre has now been completed, and it has been shown to be unsuitable as a substitute for jute in the manufacture of a coarse yarn. There remains the possibility that this bast would form a useful raw material for paper, if available in adequate quantities.

Previous to this, more than one report has been devoted to the subject of sisal and mention should be

made of the report drawn up by Mr. H. W. Jack, B.Sc., M.A. (Economic Botanist), in collaboration with R.O. Bishop, M.B.E., A.I.C. (acting Agricultural Chemist), and J. N. Milsum (acting Agriculturist). Here, the opening paragraph (in *The Malayan Agricultural Journal* for November, 1924, Vol. xii, No. 11) points out that the purpose of the report is to draw attention briefly to the industrial possibilities of sisal hemp in Malaya, since records compiled by the Department of Agriculture show that this crop can be grown successfully under local conditions, and that the leaves contain a good average percentage of fibre of suitable length and quality.

When, however, in that year of Grace, this report truthfully remarked on the demand for sisal having outstripped the supply, one is forced to bring that story right up to date, and say that at the end of 1928, it was claimed that there was a surplus of the fibre, the world being unable to digest the supplies she has been given to consume of late. Some put the surplus at over 500,000 bales. Is this an exaggeration or not? In any case, several letters came "tearing in," from widely separated areas, when it was known that this book was likely to appear, urging the writer, whatever he did, "not to urge anyone to plant more sisal." What does the sisal world say, for or against such advice, which amounted to a prayer in some cases, in others almost a threat of serious consequences if the book was looked upon as an encouragement to do so.

In 1924, however, the sisal producers were remembering that in 1922, Kenya was reported to have 22,000 acres under sisal, and that in 1913, the year before the War, 61,000 acres were planted in Tanganyika, whilst in 1923 the Dutch East Indies exported 26,680 tons of sisal, of which 75 per cent. was shipped to the United States and the remainder

to Holland and Germany. This being so, it seemed as if Malaya would do well with the cultivation of sisal added to her other industries. Can it be claimed that this is so to-day?

In any case, it is nearly a quarter of a century since sisal was first introduced into the F.M.S., as in 1905 a small area in Kuala Lumpur was planted together with other plots devoted to bowstring, manila and Mauritius hemp. In 1909, the samples of sisal shown at the Agri-Horticultural Show in Penang gained favourable comment. The above experimental block at Kuala Lumpur flowered in 1911, producing sufficient bulbils to plant up several acres in that area and also at Gunong Angsi in 1912, whilst a fresh lot of material was imported from the Philippines during the next year, and a few acres planted at Batu Tiga and in Kuala Lumpur.

THE SOIL RECOMMENDED.

The Malayan report went on to say that in East Africa, and other sisal growing countries, it has been shown that a porous soil is essential for the successful cultivation of this crop. The root system of the sisal plant is very active and demands large quantities of oxygen from the air, and this can only be done when the soil is porous. This is why it is necessary on flat land to have efficient drainage, and why the best growth, in Malaya, is made in soils containing a relatively large proportion of coarse sand, i.e., of soil of a porous consistency. It is probable, adds the report, that excellent growth could be made with sisal in the rich chocolate loams obtaining in parts of central Pahang. Sisal hemp will not grow successfully under shade, so must be ruled out as a catch-crop under rubber.

BULBILS *v.* SUCKERS.

Opinions differ as to which of the above is best, but experiments are in operation to test the relative advantages of both methods of propagation. For bulbils, the nurseries should be laid out on good land, not subject to wash. The beds should be about four feet wide, interspaced with paths a foot wide. The surface soil from the paths should be lifted and placed on the beds, resulting in the land being raised and thus affording good drainage. The bulbils usually fall from the poles when they are about six inches long. They should be collected and planted directly in the nursery beds ; exposure to the sun as in the case of suckers being unnecessary. Most of the bulbils will show roots and will make rapid headway in the loose soil of the nursery beds. The bulbils are spaced in the beds about one foot each way. No shading or watering is necessary in this climate (Malaya). Little cultural attention is required beyond periodical weeding. The plants are ready for transplanting to the clearings within a year, when they will be from twelve to fifteen inches high.

Coming to suckers, these, on established plantations may be severed from the plants in the clearings and either grown on in nurseries or planted direct into the field. After collection, they should be placed in the full sun for several days to enable the wounds to heal, as doing so prevents the plants from rotting. It is found necessary to allow suckers about three inches more space than bulbils in the nursery beds, but the subsequent treatment can be the same as that given to bulbils.

HABITS OF GROWTH IN HAWAII.

Whilst on this point it may be best to include the following from Frank Conter's Bulletin No. 4, published in 1903, on Sisal Cultivation in Hawaii,

where he reminds us that the roots of the sisal plant feed near the surface, and do not descend to any great depth, say, rarely over 12 inches in hard clay and over 18 inches in loose, rocky soil. When given sufficient room, however, the roots will generally spread out over an area equal to that covered by the mature leaves.

Mr. Conter used the name "bulbs" indiscriminately for suckers or bulbils, for this is how he wrote, the words in brackets being my own:—

"When the plants have become firmly established in the field, the main stalk throws out underground runners or rhizomes (see p. 176). The point of such a runner reaches the surface beginning with the second year and forms a bulb (sucker). This bulb is known as the sucker or shoot. This sucker takes root and obtains nourishment through the runner from the old plant and also through its own root (as illustrated). New suckers continue to appear during the life of the plant.

"After a vigorous growth of about six years, which may be extended to seven or even nine years after planting, a central stalk or pole grows up rapidly. This pole is 4 to 6 in. in diameter at the base, tapers upwards and attains a height of 30 ft. It bears flowers which fall off and are replaced by 2,000 to 3,000 bulbs (bulbils). These grow to be about 6 in. long. They finally fall to the ground, and from there reproduce the plant. When this reproduction has been accomplished the leaves of the plant have become brown and leathery, and the whole mass dies and forms considerable debris."

CONDITIONS OF GROWTH.

We will continue with Conter for a little longer before going back to Malaya, for having got your suckers or bulbils it will be well to see amidst what

conditions they are likely to do best. Whilst a field of sisal subject to overflow, or to be saturated with water, is unfit for the crop, the plant requires a moist atmosphere or heavy dews, in fact it wants its liquid refreshment little and often. It is explained that the leaves gather water from the dew or rain, this water flows down the furrow of the leaf towards the stalk, and is taken up by the rootlets at the base of and in the axils of the lower leaves; it also absorbs moisture directly by the growing tissues at the bases of the leaves. Thus, given a broken and porous limestone or coral soil under the influence of a moist atmosphere and a high temperature, subject only to moderate changes, the sisal plant grows well, producing the largest quantity with a large percentage of high-grade fibre (see illustrations of sisal lands in the Mexican Section).

Hence, theoretically, a fibre plant such as sisal should be cultivated in dry rather than in humid regions, as doing so secures the largest yield of fibre. This is due to the fact that alkaline chlorides, like chloride of sodium (common salt) tend to increase the cellulose content in plants at the expense of starch and sugar.¹ Alkaline salts are usually present in a greater proportion in the soils of dry regions than in the soils of humid ones.

CLEARING AND PLANTING IN MALAYA.

Moving along, the report tells us that sisal is a crop that requires well-cleared land. Other centres mentioned do not have to discuss virgin forest land. Malaya does so, for we are told that with virgin jungle it is necessary to remove considerably more timber than is usual when planting rubber, as the

¹ In face of this statement, would not sisal plantations, apart from any profit from the fibre, prove a help to bring alkali and otherwise useless lands into cultivable use?—H.H.S.

planting distances for sisal are comparatively close, and transport of the leaves to the factory is a matter of difficulty with much timber on the land. Ideal conditions are clean-cleared lands with all the stumps and roots removed, though it is doubtful whether this is possible or practicable on account of the cost.

PLANTING DISTANCES.

At the Experimental Station, Serdang, a planting distance of 8 ft. by 8 ft. square has been adopted, but in Java this is considered too wide, and in that island 5 ft. by 5 ft. square is stated to be usually chosen. Rows 8 ft. apart with plants 5 ft. apart in the rows might do for Malaya; this would give 1,090 plants per acre. The rows should run from east to west. Planting should be undertaken during the rainy weather. After lining, holes about one foot deep and wide should be dug some time prior to planting in order to allow the soil to become weathered. The young plants are best planted with the root crown flush with the surface of the soil which should be pressed down firmly.

Unlike other centres, the Malaya report speaks of its being unnecessary for the land to be kept clean-weeded, provided lalang and blukar are kept down. The employment of creeping cover crops is not satisfactory on account of these plants climbing up the sisal, and needing constant supervision to prevent the crop becoming smothered. It might be practicable to use bushy covers, such as tephrosia. On undulating land, a system of close silt-pitting is beneficial for the purpose of preventing wash and holding as much moisture in the soil as possible.

HARVESTING AND YIELDS.

The age at which the first cutting may be taken is variable, but is usually after the third year. It has

been said that Java finds this too young, but we are not told what age they recommend. Records in Malaya speak of three or four cuttings a year with an average annual yield of thirty leaves per plant. Planted 8 ft. by 5 ft., an approximate yield of 20 tons of green leaves has been secured, giving a return of about one ton of dry fibre (against 850 to 1,300 lb. of dry fibre per acre in Java on poor land), but up to 2,650 lb. (well over one ton) has been obtained.

SISAL WASTE.

In dealing with such a crop and its high percentage of waste product, a very important item of expenditure will be the transport of the raw material to the factory for treatment. On large estates, the cheapest and most satisfactory form of transport is by means of a system of light railways. Permanent lines are laid to feed the factory, connecting with a system of movable rails from the clearings in bearing. Monorails, as in use on certain oil-palm estates, might be employed with advantage for sisal.

Returns show that on the two estates under observation, the yield of fibre (in Malaya) is comparable with the average yield in the Philippines, in Sumatra, Ceylon, or East Africa.

The optimum number of plants which an acre can carry is still a problem in planting economics of which little is known, since it is a comparatively new industry, this growing of sisal under cultivation, as compared with the prevalent haphazard, semi-wild methods existing in Central America.

RETTING NOT RECOMMENDED.

Referring to what is said in the Philippine Section with regard to retting the leaves (see p. 203), Malaya reports that the fibre obtained by the retting of leaves

is inferior to that obtained by the direct decortication of the green leaf. An interesting and useful note is one which says that the age of the plant does not cause any material difference in the strength of the ultimate fibre.

RENEWALS.

What is the planter to do when the plant poles and dies? On this point little is known, or, if known, has not been published. In Kenya, the practice has been to clean the land thoroughly after the plants die, and leave it to fallow for about a year, or to grow two bean crops on the area before replanting. This looks as if a good many plants pole and die together. What has to be remembered, however, is that with replanting—for the second and third time—poorer crops result.

The green leaves contain :—

	Per cent.
Moisture	89.58
Dry matter	10.42
Minerals	1.135
Nitrogen	0.098

Ash of green leaves :—

Silica	.56
Chlorine	.28
Sulphuric acid	.88
Phosphoric acid	3.29
Lime	33.40
Magnesia	15.37
Manganese	—
Potash	18.80
Soda	1.42
Iron	.69
Carbonic acid, &c.	25.31

Makes ... 100.00

The fibre contains :—

	Per cent.
Moisture	11.75
Dry matter	88.25
Minerals	2.24
Nitrogen	0.084

Ash of fibre :—

Silica	.442
Chlorine	.888
Sulphuric acid	.784
Phosphoric acid	2.605
Lime	36.247
Magnesia	1.449
Manganese	.151
Potash	15.776
Soda	1.297
Iron	—
Carbonic acid, &c.	37.595

97.234

What can be done to maintain the fertility of such areas? That is a query that we will try to answer later, but meanwhile let us dip once more into the story that Frank Conter has to tell us of sisal in Hawaii, where, on p. 15, he points out that the sisal

plant feeds most heavily on lime, magnesia, potash, and phosphoric acid. This will be at once apparent by a glance at the preceding table giving the composition of the ash; (1) of the whole leaf, and (2) of the fibre.

What will the fertilizer experts tell us to do to adequately replenish the above loss of plant food with economy and yet sufficiently?

Generally speaking, the report considers that Malaya—of course, certain areas of it—is well suited to the commercial development of sisal plantations, because of the facilities which exist there for the acquisition of suitable lands, and because easy transport, adequate labour, and efficient management also abound. This report was published in November, 1924, so probably is based on observations made during 1923 and 1924 if not earlier still.



FIG. 5.—Sisal suckers, either side of mother root.

CHAPTER VI

CAICOS ISLANDS

IN the Memorandum drawn up in 1907 by Mr. F. H. Watkins, when Commissioner of the Turk's and Caicos Islands, with special reference to the further development of the sisal industry over there, the following particulars—not likely to become out of date—were given, so that it might be as well to embody them here.

The Turk's and Caicos Islands geographically form a sort of annexe (not of Jamaica) but of the Bahama Group, from which Government they were separated in 1848. In 1873 they were annexed to Jamaica, from the north-east of which they are distant some 450 miles. One would associate the soil conditions generally rather with that of the Bahamas (known to the Carib Indians as Sucayos, from whence, so some believe, comes Caicos, Cays or Keys, all names of the rocks or islets around Grand Turk and the Caicos Islands, generally) than with any other of the islands around, whilst of course with regard to sisal production the Bahamas in turn take you on to Florida which is also well in the sisal zone, for the Bahamas, with twenty inhabited and innumerable smaller islands, run out from the east coast of Florida and the north coast of Cuba on towards Haiti.

The surface of the islands is flat and undulating, the highest elevation, the Blue Mountain in Providenciales, being about 280 ft. high, with Flamingo Hill, 270 ft., and Good's Hill 200 ft., in East Caicos. This island (East Caicos) is about fifteen miles long

from east to west, and ten miles north to south. It is interesting, Mr. Watkins tells us, as being the scene of operations of the East Caicos Company formed in 1900, one of the pioneers of the sisal industry in the dependency, where they seem to have owned some 10,580 acres, i.e., 9,233 in East Caicos and 1,347 acres in Sail Rock. It owned 14 miles of tram lines and two main branches with loops, along which the trolleys were drawn by mules. In 1906 they extracted 219,365 lb. and shipped 514 bales. On Grand Caicos, an estate of several thousand acres, named "Haulover," was described as being most suitable for sisal, but to what extent its cultivation was carried out is not stated. Judged by the size and vigorous growth of the few sisal plants to be found in North Caicos, the land there would be admirably adapted for fibre cultivation. Blue Hills or Providenciales has much elevated land at the foot of which is to be found soil suitable for sisal growing, whilst in West Caicos Islands are to be found the lands occupied by the Pita Company, Ltd. Remember this refers to twenty years ago and not to recent times during which we have been hearing so much of pita and fique fibre, both from the South American Republic of Colombia, since the war. In this island some 4,000 acres had been planted to sisal, but they dwindled to 800 and then started to mount up again and employed a traction engine capable of carrying or dragging 15 tons, to convey the leaves to the factory. During the ten years, 1897 to 1906, the Caicos Islands as a whole exported sisal to the value of £56,550, but unfortunately the weight is not given as well.

Here is a note from p. 15 of the report which may interest some readers: "Captain Jackson, fully alive to the important results which might accrue to the islands if once the cultivation of sisal could be established as an industry, sent on for verification to

the Royal Gardens at Kew specimens of the fibre plants found in the group. Upon examination, one of the specimens was identified by Dr. (now Sir Daniel) Morris as the true pita, or sisal of commerce (*Agave rigida* var. *sisalana*).” One wonders what Mr. Dawe from his retreat in Cyprus would have to say to this idea that pita and sisal are, in name, the same.

As far back as 1889, Captain Jackson (was he afterwards Sir Henry Jackson, whom the writer knew later as Governor of Trinidad?) claimed that sisal growing in the Caicos group offered no such uncertainty to the inhabitants as did their usual industry of salt-raking, and here again is the name pita used for sisal, as we are told:—

“The pita, which of all the agaves grows most readily here and arrives earliest at maturity, gives as well the strongest and best fibre now known in the market. Unhurt by storm or calm, rain or drought, these plants offer the perennial harvest in return for less labour and, in comparison with the value of the crop, for far less outlay than any other product. . . . The soil here is singularly adapted for the pita, and I have seen numbers of plants, only three years old, with fully-matured leaves, 6 ft. in length, furnishing fibre of the highest quality. . . . If public attention can only be directed to the very unusual facilities afforded by these islands for pita cultivation, I believe the capital necessary would be attracted to the industry.”

THE CAICOS VOTE FOR SUCKERS.

Regarding bulbils *v.* suckers, we are told that, except in the early stages of the industry bulbils, as a method of propagation, have never been used, for they cause too much time to be lost. Sometimes the top of a nearly worn-out plant, just before it poles, is cut and, after being trimmed of all but the newest leaves, is planted in the ground. This method,

though rarely used, is said to cause early production but when a plantation is fully established the most economical method of propagation, and that invariably adopted in the Caicos Islands, is by suckers. As these suckers draw nutriment from the plant they should, when not required for propagation, be removed, for they cause the parent plant to produce fewer and smaller leaves; they also hasten its period of maturity. Great care should be taken that the suckers, which are planted with iron drills, be kept in an upright position by placing stones as a support at the base. As a proof of the marvellous vitality of the plant, suckers when used, still grow even after remaining for some months out of the soil.

CLOSE PLANTING—IS IT BEST?

Sisal is planted in rows the same distance apart and with equal spaces between the plants in the row. In Yucatan, sisal was planted about 9 by 9 ft. in the row with intervals of 15 or 18 ft. at certain distances to allow the leaves and young shoots to be carted out. The tendency, however, in 1906-7 was to plant more closely than formerly. At East Caicos, the distances between the rows and plants have been more and more reduced, as experience has proved the feasibility of the reduction by gradual stages, viz.:—

Stages				Distance between rows and plants
First Stage	...	...	...	12 × 12 feet
Second Stage :—				
First Row	...	...	...	10 × 4 "
Second Row	...	...	...	10 × 4 "
Third Row	...	...	...	10 × 4 "
Third Stage	...	...	...	8 × 8 "
Fourth Stage	...	...	...	6 × 6 "
Fifth Stage	...	...	...	4 × 4 "

In West Caicos, the planting (in 1906-7) was $4\frac{1}{2}$ by $4\frac{1}{2}$ ft. On the one hand it is contended that close planting will not only increase the production but will

also keep down weeds ; on the other hand, the objection is made that during heavy winds the leaves of one plant, especially when placed in favourable soil, are liable to injure those of its neighbour. Owing to the character of the soil in the Caicos Islands, uniform distances are often out of the question, and this is a point seriously to be considered when estimating the yield per acre, a point for which considerable allowance should be made. For instance, planting $4\frac{1}{2}$ by 4 ft. and 4 by 4 ft. apart would give, provided it were possible to maintain equal distances, 2,175 and 2,722 plants to the acre, but, as a rule, it would be wise to reduce these numbers by at least one-third, and estimate about 1,500 and 1,800 plants to the acre respectively.

THE QUESTION OF MANURE.

Personal observations made when comparing what are called the different cultivations, that is, the first, second or third time of planting, convinced me that sooner or later the question of manuring and replenishing the land will become of urgent importance ; fortunately the means, though neglected, of providing cheap fertilizers are at hand. The bagasse, or pulp remaining after the extraction of the fibre, contains a considerable quantity of potash, and would, after being mixed with earth or other vegetable matter and well rotted,¹ furnish a most useful manure or mulch. At present there exists so deplorable a lack of appreciation of the value of this bagasse for fertilizing purposes, that a tram-line was laid down at one place for the sole object of dumping it into the sea. Seaweed in large quantities, so far as the Caicos Islands are concerned, is also to be had close to the land, suitable

¹ Probably in these days a preparation like Adco would be added in order to help break down the vegetable and other matter.

and available as a fertilizer for the sisal or any other crop in the neighbourhood.

So important is this matter for would-be planters' consideration, that Mr. Watkins was induced to forward to the planters and managers a circular embodying a scheme of elementary manuring experiments with the hope of enabling them to gain definite knowledge on the importance of manures to the smallest holdings, and as to how such manure can be obtained and applied at a comparatively trifling cost.

LIFE AND GROWTH OF THE PLANT.

The above statements caused the author of the report to remind his readers that the soil of the Caicos Islands enabled the plants to be ready for gathering within three or four years after the first planting, and within five years after the second planting; this fact, he points out, seems to prove sufficiently that a certain amount of virtue was taken out of the land during the first period of cultivation, and should be replaced. We are also reminded that great care is necessary lest the premature cutting and reaping of the leaves should take place, for when this is done the plant sustains a shock which is prejudicial to its growth and vigour. When the leaves drop and assume a horizontal position, this is almost a certain indication that they should be cut. The cutting of the leaves retards poling, which may take place any time from four years old and upwards. In Yucatan it is the custom to remove the pole as soon as it appears, and the plant is then said to live for fifteen years.¹ But in the Caicos Islands the average life of the plants, under present conditions and methods, may be put down at eight years, and replanting has to take place every eight years.

¹ Elsewhere, of course, it is pointed out that the plants in Yucatan last for twenty and even twenty-five years.

WITH REGARD TO YIELD.

Against yields spoken of in Yucatan of 50. lb of fibre per 1,000 leaves, increasing even up to double that amount, with an average yield from good plants in their fifth and seventh years of 75 lb. of fibre per 1,000 leaves, giving an average production of half a ton of fibre to the acre, in the Caicos Islands, 120 leaves may be taken as the average yield during the life of a plant, each leaf weighing from $\frac{3}{4}$ lb. to 1 lb.

Each plant should, therefore, produce on an average 15 leaves a year during its lifetime of eight years. With 1,500 plants to an acre, this would give 22,500 leaves to be gathered annually. Work these out at an average weight per leaf of $\frac{3}{4}$ lb. to 1 lb. and a minimum of 4 per cent. of extracted fibre, then you would get from 1,000 leaves between 30 lb. and 40 lb. of dry fibre, and an acre with its 22,500 leaves should give an annual average crop of 675 lb. to 900 lb. of fibre. If elsewhere a yield of 50 lb. of fibre per 1,000 trees is obtainable, this would bring up the output to 1,125 lb. of fibre, that is to say, to the half ton per acre, during the lifetime of the plant, which seems to be a generally accepted average yield.

When cropping the leaves, it is well to remember the advice given by Sir Daniel Morris to decorticate the leaves as soon as possible. It was when discussing what he said on the matter that the writer, trying to "fix things right," had the pleasure of corresponding with the authorities over in Washington, as mentioned in the introduction, with regard to the possibility of running a portable decorticator out into the field; up to the present, this has only proved to be practical in one case. Returning to what Sir Daniel Morris told us, his advice runs as follows: "It is of the highest importance that the fibre should be extracted from the leaves immediately they are harvested.

When agave leaves are allowed to be exposed to the sun and air after being cut, they lose their natural moisture, which is useful when cleaning them; furthermore, the juices set up a fermentation which, if continued long, will seriously injure the quality of the fibre. A practical rule for the working of a sisal plantation would be that the leaves cut in the morning should be cleaned the same day, and that the leaves cut in the afternoon should be put in hand the first thing the next morning."

DRYING AND BALING.

Moving on to drying and baling the crop, we are told that rapid drying is to be avoided, a word of advice that equally applies to most crops in which the modern tendency for speeding up often causes deterioration through over-rapid drying, whether it be cacao, copra, or other crops. Great attention must be paid to the grading of the fibre, otherwise the price of the best quality will be lowered to the level of the lower quality found mixed in the bale, even if only to a small degree, and furthermore, no buyer likes "mixed goods"; given a recognized mark, you must feel confident that the fibre will turn out to type every time. In conclusion, it might be mentioned that two disadvantages are at times thrown up against the cultivation of sisal as an industry, one being the time taken before a return can be expected. This is common with most crops, and at any rate the four or five years that sisal takes to arrive at the leaf-bearing stage is better than the five to seven years taken by cacao, or up to ten years by the coconut plant. Another objection is that, in those arid lands where sisal can be grown, other crops, either catch crops or rotation, do not flourish, but surely this is greatly in favour of sisal production, since in such extreme cases

it would enable a man to utilize his land by the one means alone which Nature offers him to do so.

With regard to the disposal of the refuse, this we are told supplies, fortunately for the planter, a cheap fertilizer close at hand. The bagasse or pulp remaining after the extraction of the fibre contains a considerable quantity of potash ; this will, after being mixed with earth and vegetable matter and well rotted, furnish a most useful manure or mulch. At present there exists a deplorable lack of appreciation as to the value of such a compost. This causes much money, sadly needed probably to help extend the estate, to be thrown away twice over, first in laying down a tram line, or supplying other means to remove and dump an undesirable if not actually a dangerous debris far from the factory, and secondly on account of the loss of a useful crop-food through so doing. It is such mulls as this, or their avoidance, which cause one estate to lose money and another to show a profit.

Having surveyed the Empire production of sisal compared with that of Mexico, let us turn to that country, and state its case from the Mexican point of view.

CHAPTER VII

MEXICO

THE close student of sisal production anywhere, and throughout Yucatan in particular, will find it of considerable value were he to thoroughly study the map of the two Americas from where Mexico merges into the United States and then down to where the chain of Central American Republics joins on to Colombia. This done, then travel from Yucatan eastward to Jamaica and the Caicos Islands and round to the coral island of Barbados. This done, ask yourselves whether, since henequen (whatever its real family name may be) does so well in Yucatan, could it be cultivated to pay in the coral, i.e., the limestone soil of Barbados and similar islands throughout the tropical belt, given the room to do so on a sufficiently large scale.

In his excellent report on the sisal industry of Yucatan (translated from the Spanish into English by his namesake Señor Diego Diaz de Cossio), Martin Diaz de Cossio has much to tell us that is worth noting if only for comparison with what we now know of other sisal-producing centres. Apart from this, there is a lot to learn with regard to the nature of the soil, the climate, &c., in order to try and ascertain why the crop does not do so well—or does better—elsewhere both in the quantity and quality of the resultant fibre.

It has often been said that the Mexican fibre is rougher and coarser than our own, i.e., British-grown sisal, but against this we are told that whatever may be the case to-day, "the fibre was extracted and

employed in various uses. The natives wove it (that is a particular variety or varieties) so finely that it hardly seems possible in our time, with new and improved machinery even to match their fine work. The fibre was also utilized for cordage purposes and for weaving roughly, the resulting product being used for covering houses and native buildings because it was found by experience that a building so protected was untouched by insects. The first Spanish explorers were soon aware of the properties of this fibre that they found in Yucatan. In their memoirs and letters mention is made of a fibre utilized by the natives that was so strong and vigorous it resisted even the action of time and salt water, and so they likewise availed themselves of it extensively for their vessels in the shape of cord, twine, &c." In 1839, the first shipment was made to New York, whilst in 1916, their banner year, 202,000,000 kilos, or 1,191,433 bales of 180 kilos each, were exported to all centres (see table on next page, p. 188).

The *Yucateco*, to use the Spanish term for the Maya native of Yucatan, having realized the soil and climatic conditions of his country, discovered at least one plant that suited the soil he owned, and now for a century, he has made the best of his possessions but with what benefit to himself as compared with the owners of the plantations and decorticating factories, since the outside world began to call for his fibre is not for this book to say.

According to de Cossio there are over a thousand different plantations in Yucatan with an average annual crop capacity of 200,000 tons of fibre. At (roughly) six bales to the ton, this means 1,200,000 bales. Apart, therefore, from the fibre needed for home consumption this estimate looks like being correct in face of the following table taken from p. 36 of Señor Cossio's report :—

STATISTICS OF THE SISAL EXPORTS FROM YUCATAN FOR THE YEARS
1880-1926 (INCLUSIVE).

Year	Bales	Kilos	Year	Bales	Kilos
1880	112,911	18,178,994		7,990,305	1,293,058,574
1881	154,730	24,911,587	1904	606,008	67,205,649
1882	150,585	24,244,174	1905	597,289	96,534,196
1883	202,805	32,651,597	1906	599,568	97,198,252
1884	261,137	42,043,070	1907	611,845	100,773,946
1885	267,478	43,063,891	1908	652,498	108,794,721
1886	242,791	39,089,463	1909	567,427	95,755,937
1887	224,865	36,283,351	1910	558,996	94,789,504
1888	218,129	35,118,767	1911	680,990	116,547,349
1889	252,432	40,641,521	1912	814,610	139,901,951
1890	279,906	45,079,423	1913	836,950	145,279,963
1891	323,585	52,065,024	1914	964,862	169,285,897
1892	363,881	58,584,813	1915	949,639	162,743,515
1893	360,857	58,097,929	1916	1,191,433	201,990,440
1894	373,883	61,605,695	1917	733,832	127,092,043
1895	383,413	61,729,584	1918	798,862	140,000,706
1896	397,163	65,762,907	1919	650,691	113,869,925
1897	419,975	70,545,153	1920	918,624	160,759,200
1898	418,972	68,834,268	1921	610,253	106,794,275
1899	445,978	73,190,896	1922	450,343	78,809,025
1900	499,634	81,093,418	1923	570,981	102,925,263
1901	517,519	83,191,007	1924	614,914	109,265,492
1902	528,246	83,993,076	1925	703,218	128,141,872
1903	590,430	93,058,966	1926	555,360	101,156,827
Totals...	7,990,305	1,293,058,574	Totals...	24,230,498	4,088,673,922

Average export for 47 years, 515,542 bales.

" " " 10 years, 1907-1916, 782,925 bales.

" " " " 1917-1926, 660,707 "

Against 1,191,433 bales exported in the one year, 1916.

So much for the fibre exported, now for the area producing that fibre as well as any used for "home consumption."

Statistics showing the number of plantations, large and small, belonging to the members of the Yucatan Henequen Growers' Co-operative Society, Ltd.

DEPARTMENT OF STATISTICS.

Yucatan covers 42,750 square kilometres (sq. k = 0.38611 square mile) and is considered to have a population of 357,500, fairly well divided between the two sexes. Geographically, as regards the Greenwich meridian, the area lies latitude north 19° 30'—21° 37' and longitude west 87° 32'—90° 25'. With a tropical

TABLE SHOWING ALL PLANTATIONS, PLACES AND URBANIZED PROPERTIES WHICH MAKE UP ALL DEPARTMENTS AND MUNICIPALITIES OF THE STATE OF YUCATAN, MEXICO.

Departments	Properties				Mecates of henequen under cultivated plants					
Name	Plantations	Places	Farms	Totals	Under cultivation		Without plants		Net with plants	
					Mecates	Frac	Mecates	Frac	Mecates	Frac
Tizimin ...	4	0	0	4	00	0	0	0	0	0
Peto ...	4	0	0	4	400	0	100	0	300	0
Progreso ...	2	0	0	2	4,083	0	222	65	3,860	35
Valladolid...	18	5	50	79	4,608	0	278	70	4,329	30
Espita ...	26	8	0	34	11,150	0	1,486	53	9,663	47
Sotuta ...	21	16	191	228	21,296	0	1,201	90	20,094	10
Tekax ...	23	11	23	57	14,422	0	2,472	26	11,949	74
Ticul ...	40	15	129	184	44,923	0	3,345	31	41,577	69
Temax ...	64	19	508	591	82,994	50	3,460	03	79,534	47
Maxcanú ...	30	28	86	144	79,552	0	4,102	47	75,449	53
Izamal ...	72	12	417	501	146,679	0	8,534	96	138,144	04
Motul ...	75	40	1,908	2,023	144,597	0	6,349	98	138,247	02
Hunucmá ...	63	37	438	538	149,930	0	5,245	43	144,684	57
Tixkokob ...	74	17	1,554	1,645	160,570	50	7,589	97	152,980	53
Mérida ...	70	0	293	363	158,896	0	5,662	45	153,233	55
Acanceh ...	74	18	659	751	209,902	0	8,694	82	201,207	18
No. of Departments, 16 ...	660	226	6,256	7,148	1,234,003	00	58,747	46	1,175,255	54

TABLE SHOWING ALL PLANTATIONS, PLACES, &C.—continued.

Departments	Properties				Mecates under self-planted henequen					
Name	Plantations	Places	Farms	Totals	Under cultivation		Without plants		Net with plants	
					Mecates	Frac	Mecates	Frac	Mecates	Frac
Tizimin ...	4	0	0	4	10,325	00	2,792	50	7,532	50
Peto ...	4	0	0	4	13,302	00	3,281	95	10,020	05
Progreso ...	2	0	0	2	37,466	00	26,692	05	10,773	95
Valladolid...	18	5	50	79	53,799	00	31,033	96	22,765	04
Espita ...	26	8	0	34	110,444	00	52,429	03	58,014	97
Sotuta ...	21	16	1	228	85,236	00	25,752	50	59,483	50
Tekax ...	23	11	23	57	105,621	00	37,981	51	67,639	49
Ticul ...	40	15	129	184	223,219	00	80,399	52	142,819	48
Temax ...	64	19	508	591	339,947	50	105,092	05	234,855	45
Maxcanú ...	30	28	86	144	441,001	00	175,227	54	265,773	46
Izamal ...	72	12	417	501	436,962	00	135,582	68	301,379	32
Motul ...	75	40	1,908	2,023	508,882	00	141,048	65	367,833	35
Hunucmá ...	63	37	438	538	591,394	00	216,315	92	375,078	08
Tixkokob ...	74	17	1,554	1,645	534,155	50	163,075	69	371,079	81
Mérida ...	70	0	293	363	508,131	00	126,949	81	381,181	19
Acanceh ...	74	18	659	751	626,631	00	194,062	89	432,568	11
No. of Departments, 16 ...	660	226	6,256	7,148	4,626,516	00	1,517,718	25	3,108,797	75

TABLE SHOWING ALL PLANTATIONS, PLACES, &c.—*continued.*

Departments	Properties				Total number of mecates with henequen plants					
Name	Plantations	Places	Farms	Totals	Under cultivation		Without plants		Net with plants	
					Mecates	Frac	Mecates	Frac	Mecates	Frac
Tizimin ...	4	0	0	4	10,325	00	2,792	50	7,532	50
Peto ...	4	0	0	4	13,702	00	3,381	95	10,320	05
Progreso ...	2	0	0	2	41,549	00	26,914	70	14,634	30
Valladolid ...	18	5	50	79	58,407	00	31,312	66	27,094	34
Espita ...	26	8	0	34	121,594	00	53,915	56	67,678	44
Sotuta ...	21	16	191	228	106,532	00	26,954	40	79,577	60
Tekax ...	23	11	23	57	120,043	00	40,453	77	79,589	23
Ticul ...	40	15	129	184	268,143	00	83,744	83	184,397	17
Temax ...	64	10	508	591	422,942	00	108,552	08	314,389	92
Maxcanú ...	30	28	86	144	520,553	00	179,330	01	341,222	99
Izamal ...	72	12	417	501	583,641	00	144,117	64	439,523	36
Motul ...	75	40	1,908	2,023	953,479	00	147,398	63	506,080	37
Hunucmá ...	63	37	438	538	741,324	00	221,561	35	519,762	65
Tixkokob ...	74	17	1,554	1,645	694,726	00	170,665	66	524,060	34
Mérida ...	70	0	293	363	667,027	00	132,612	26	534,414	74
Acanceh ...	74	18	659	751	836,533	00	202,757	71	633,775	29
No. of Departments, 16 ...	660	226	6,256	7,148	5,860,520	00	1,576,465	71	4,284,053	29

Note.—The 660 plantations above referred to are *Decorticated Central Plantations*. Each is made up of two or more plantations which are estimated as being “annexed” to the main or central plantation. “Mecate” is equivalent to 404.49 square metres. 10,000 square metres = 1 hectare or 2.4711 acres. Therefore 10 mecates roughly equal 1 acre.

climate its surface is one vast plain surrounded by warm seas. It is fed with considerable dews which invigorate and rejuvenate the plant life and enable the *agaves* and other vegetable growth to resist prolonged droughts whilst depriving them of that surplus “flesh” which possibly helps greatly to improve the quality of the fibre. As most of us know, Yucatan rests on an immense bed of limestone composed of carbonate of lime, clay and flint, and on this the *henequenero*, if not the henequen itself, thrives and grows rich.

“El Henequen—manual practico—Su cultivo y explotación,” by José A. Bolio, is considered to be THE book on the industry, and its author is looked upon as the highest authority on the subject. There

are several varieties of the plant recognized by the Yucataneros themselves, leading off with Sac-ci the pet of the flock.

THE SAC-CI VARIETY.

This variety, de Cossio tells us, is botanically known as *Agave fourcroydes* of Lemaire. (See No. 6 in the table on p. 192). The henequen growers of Yucatan have selected this kind from among its fellows because of its power of resistance to variations of temperature and the various "plagues" that the plants are heir to, as well as on account of the quantity and quality of the fibre produced and the length of its life.

Sac-ci fibre, we are assured, is exceptionally strong, hard, tough and white in colour. For twine- and cord-making it has no known rival, especially as it seems to be quite immune to insect life and attacks even when, as binder-twine, it may be left in the field exposed to bad weather for some time. All of this must be news to many of us, both as growers of sisal, using that popular term, buyers of the fibre and users of the cordage and twine made from it. All may be known to the trade as sisal, but how many know how to discriminate and choose Sac-ci sisal from among its rivals, the list of which, in Yucatan, is shown in the table on the next page?

Evidently the Sac-ci variety is mainly planted, only in that case one wonders why it has been placed sixth in list. "As can be readily seen from the above table," de Cossio goes on to say, "several varieties of the plant are known and cultivated in Yucatan, but up to the present, no special importance has been paid to those, other than the Sac-ci kind, as it has proved to be the most adaptable for general manufacturing purposes. Now, however, since there is a call for henequen fibres to be used for purposes other

YUCATAN HENEQUEN OR SISAL. PARTICULARS OF EIGHT VARIETIES.
(AFTER MARTIN DE COSSIO.)

Variety	Height of plant	Length of leaves	Width of leaves	Produc- tion	Produc- tion per 1,000 leaves	Pro- duction begins	Life of plant
	Metres	Centi- metres	Centi- metres	Leaves yearly	Kilos	Years	Years
QUINTAN-CI (1) ...	2'50	85-125	12	35	12-15	4-5	15-20
BAB-CI (2) ...	1'50	100-110	7	30	10-12	4-6	18-20
CAHUN-CI (3) ...	2'10	200-210	16	30-36	12-15	4-6	20-25
CHELEN-CI (4) ...	1'50	80-90	7	25-30	6-12	6-8	20-22
YAC-CI (5) ...	2'10	125	12	25-30	20-35	4-6	20-25
SAC-CI (6) ...	1'67	145	12	25-30	25-45	5-7	25-30
CHUCUN-CI (7) ...	1'67	125	12	25-30	15-40	5-7	25-30
XIX-CI (8) ...	1'67	118	24	25-30	25-50	6-8	25-30

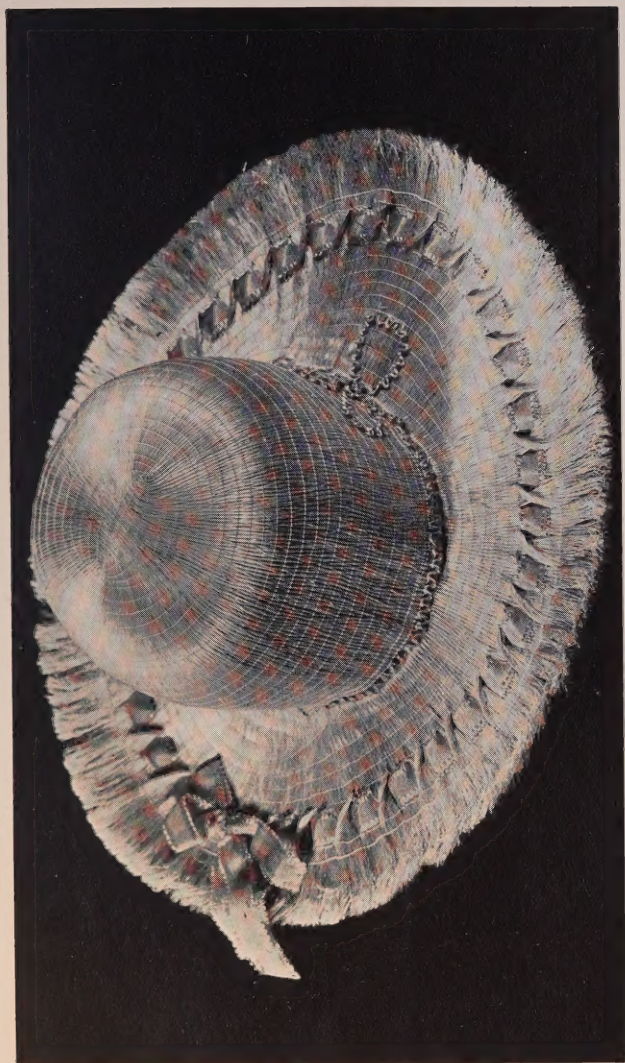
- (1) Fibre from this variety is soft, quite thin, silky, strong and of white silk colour.
- (2) This fibre is soft, thin, silky, strong and of white pearl colour.
- (3) This fibre is extra soft, silky, quite strong and of straw colour.
- (4) Medium soft fibre, tough, quite strong, somewhat sticky and of yellowish colour.
- (5) A silky medium-soft fibre, quite strong, somewhat sticky and of clear greenish colour.
- (6) Heavy fibre, tough, strong, sticky and of white colour.
- (7) Medium fine fibre, tough, strong, sticky and of a cream white colour.
- (8) Exceptionally heavy fibre, tough, quite sticky, strong and of a greenish white spotted colour.

than the making of cordage and twine, it will not be long before all these varieties are extensively cultivated as well, and even the finer and more silky kinds placed on the world's markets."

HOW HENEQUEN STARTED TO TRAVEL.

Let it be firmly and emphatically stated, proudly claims Señor de Cossio, that all the henequen or sisal produced in the world has come from Yucatan or from plants originally taken from there. The henequen plant became known outside its original home in 1836, when Mr. Henry Perrine, the American Consul at

PLATE IX.



Hat made from Yucatan sisal fibre.
Note how soft and silky it is.

After de Cossio

PLATE X.



Young sisal (Henequen) in Yucatan.

Note the rocky nature of the ground as so often described.



After de Cossio

Old sisal (Henequen) in Yucatan.

The tall plants are said to be 23 to 25 years old. What can they be like at twice that age?

Campeche (the peninsula of Yucatan, it may be remembered, is made up of the two States of Campeche and Yucatan proper) succeeded in transporting to Florida some *hijos* (sons) or baby henequen plants. Years later plants were also introduced into the Bahamas and to Cuba. From Florida, in 1897, a thousand *hijos* were shipped to Tanganyika, then a German possession, and of these about half survived and served for the introduction of the plant throughout East Africa and elsewhere. It was taken into Kenya in 1904, and now Yucatan tells you these two colonies alone turn out some 40,000 tons a year, with Java, Sumatra and the Far East coming along rapidly as well.

Java has some "cantula"¹ fibre; this, it seems, is friend Yac-ci, No. 5 in the list; it also came from Yucatan in the first place. How it got out is not stated, but apart from that, in the same way as we owe to-day's plantation rubber industry to the late Sir Henry Wickham, and Brazil, so does it seem that the world at large owes its famous and ever-increasing sisal areas to another Henry, viz., Mr. Henry Perrine, and Yucatan.

Although this interesting report covers less than forty pages it tends, with any slight knowledge of sisal that one may already possess, to "egg" you on to unknown lengths concerning the production of sisal in Yucatan, and its preparation and grading for market. Again, if one finds no price for this interesting report, nor any address where copies can be obtained—it was printed in Barcelona, and we owe our copy to the courtesy of the Commercial Attaché of the Mexican Legation at Bush House in London—yet it would not be fair to the author to say much

¹ Often spelt "cantala," but surely "cantula" is more correct.

more. We note, however, that Señor de Cossio strenuously protests against any claim being made that the methods of cultivating the henequen plant in Mexico are still primitive. On the contrary, he maintains that, after what "I have observed personally in Java and East Africa in comparison with Yucatan, I found that where cultivation is still in its infancy is in the English and Dutch possessions." Unfortunately, we are given no useful particulars as to how the necessary labour is obtained and how it is paid and "handled" in Yucatan, even to this day, as compared with Java, Sumatra or our own colonies. Before a proper comparison can be made, such particulars must be ascertained and investigated. It is a pity that this cannot be done straight away, for one feels sure that, were such a proposal to be carried out along correct lines, our Colonial methods would prove to be the best of the bunch. Were it not so, surely we should not have progressed as we have done, and, one likes to think, are doing and will do for quite a good time yet.

THE LONG LIFE OF THE YUCATAN PLANT.

If it is to Yucatan's improved methods, as well as to her soil and climate, that her plants continue to yield for so long then by all means let us see how they work the oracle, since we are told that the henequen plant in Yucatan lives for thirty years. Since they do not seem to make use of it until its sixth year, this means that "the plant in Yucatan is a steady producer of fibre for twenty-four consecutive years. A wonderful record, indeed, for such a small plant."

Why do the plants go on yielding in this way? Is it due to cutting out the pole, when it starts to grow, or to the inhospitality of the soil, causing those plants that do survive their childhood to become so tough that they live for ever, or at least for four or five

times as long as elsewhere? Again, do all the plants go on yielding commercial sisal for twenty-four years, and if not what percentage does, and also what percentage fails, when the plants are, let us say, ten, fifteen, twenty or twenty-five years old? To obtain correct answers to such queries would indeed be valuable, but to whom can we look for the replies?

YUCATAN HAS ITS OWN DECORTICATOR.

How many times, one wonders, have makers of "the best decorticator on earth" assured the writer that their machine is preferred throughout Yucatan to all others; statements which no one wants to doubt, if only because it required a personal visit to the many factories over there to find out what machines were being used. Up to the time of writing there seems to exist no way of ascertaining the facts. This being so, it is all the more interesting to see what de Cossio has to say on so important a matter, and here is his version of the story.

"The Yucatan planter has, unceasingly, been seeking out improved methods for decorticating his leaves. Finally he succeeded in designing a mechanical decorticating machine, which, however (in 1928), has been further improved upon, until to-day a machine is manufactured in Yucatan itself, as good as, if not better than, any which other countries can offer her for the work to be done.

One of the best Yucatan decorticators is known as "La Vencedora." Perhaps this is what the world at large knows as the "Prieto" machine, since we are told that it was invented and patented by Mr. Prieto and now has many improvements over the original design. The largest sizes of these Yucatan machines have a capacity of 140,000 to 150,000 leaves per day of eight hours, with a production, according to the latest statistics, of 6 per cent. fibre, against a percentage

elsewhere that is not above 4 per cent. only.¹ Following this comes a very important statement, viz., the query as to whether washing the fibre is not a mistake.

WASHING—OR *not* WASHING THE FIBRE.

"Immediately after decortication," the story continues, "the fibre, carefully conditioned [whatever that process may involve or comprise], is taken to the drying depots, whilst, in other countries, it is thoroughly washed. This same process, of washing, was experimented on in Yucatan, years ago, but after many practical observations, it was found that the fibre lost many of its inherent qualities, during the washing, especially the fibres to be utilized for manufacturing purposes. For instance, binder twine cannot be made with washed henequen, and if it is so manufactured, it will be quickly attacked and eaten by insects; in fact, the wheat sheaves, when threshing takes place, will be found unloosened and untied because of the same. Washed henequen does not easily absorb the oil with which it is impregnated for the manufacture of binder-twine and for other purposes.² There are other qualities which unwashed henequen possesses," impishly concludes de Cossio,

¹ But then it must be remembered that the "thin" nature of the Yucatan plants through the absence of water, shows a smaller percentage of flesh and so more fibre.—H. H. S.

² What do sisal producers outside Yucatan say to this? In the days of my youth we used to ship, every fortnight, sisal cordage to the West Indies, and it was spun dry to keep it as white as possible, no oil being used, as that stained it. Yet, after all this fuss, when you went to the other side and saw that same cordage being sold, what happened? The native, from up country, would buy a length, and at once start dragging it through the store, and whilst using it to tie the load on his donkey at the door, tread it into the dust or mud with his naked feet, so that it had already become anything but light or white, before he started on his journey home.—H. H. S.

“but they, for the present at least, are a secret of the Yucatan henequeneros.”

And this time I *will* stop talking about Yucatan and its sisal, but it is only fair to say that we leave off at p. 23 of the report, and that the thirteen remaining pages contain well-written descriptions of the care taken to grade every ton of fibre so that it shall be a credit to Yucatan, and then to show how the fibre is appreciated in other countries, far above all other kinds, of course, and why this is so. Here, therefore, is a challenge thrown down to non-Yucatan producers proudly claiming that Mexican sisal is the best; how long will it be before that challenge is answered in the same sportsmanlike manner in which it has been made? Congratulations to the author on it, and also to Señor Diego Diaz de Cossio for his excellent translation of so technical a subject.

With regard to the non-washing of the Yucatan sisal it is as well to remember that Messrs. Wigglesworth and Co., in their Annual Report for 1926, spoke of the uncertainty of the Mexican sisal situation, and how it was hampering sales. Efforts had been made to reintroduce the fibre on this side, but the results had been disappointing. The spinners in this country have learnt to realize the intrinsic value and advantage of our own East African sisal at a relatively lower price taking into consideration the heavier waste of Mexican fibre in the manufacture of twine. What causes this heavier waste, one is obliged to ask: would it be there to be found fault with, were the fibre washed as is done in British East Africa?

THE GRADING OF HENEQUEN.

A law was decreed on December 31, 1926, by the Mexican Congress, after public discussion, entitled “Regulations regarding the Cultivation and Exploita-

tion of Henequen." These regulations are divided into six sections or chapters. The last one is headed: "Classification of the Henequen Fibre," and Article 22 of these regulations put briefly, states that the official classification of Yucatan's Henequen shall be as follows:—

Grade "A": Clean Current Fibre. This must have a minimum length of 75 cm., shall be well cleaned, free of pulp and with not more than 5 per cent. of dust.

Grade "A-1": Short Clean Current Fibre, with a minimum length of 60 cm., must be well cleaned, absolutely pulpless and with not more than 5 per cent. dust.

Grade "B": Low Grade. Minimum length of 75 cm.; must be well cleaned, pulpless, of ash or reddish colour, absolutely dry and with not more than 5 per cent. of dust.

Grade "B-1": Short Low Grade. Minimum length 60 cm., must be well cleaned and free of pulp, of ash or reddish colour, thoroughly dry and with not over 5 per cent. of dust.

Grade "C": Spotted Henequen. Minimum length 75 cm., must be well cleaned if spotty in colour, pulpless and with not over 5 per cent. of dust.

Grade "C-1": Short Spotted Fibre, with a minimum length of 60 cm., shall be well cleaned but dark or red spotted, pulpless and not over 5 per cent. of dust.

Grade "AA": Superior. All henequen or sisal of 105 cm. in length and with not more than 3 per cent. of dust shall be considered a superior fibre and classed as such.

Article 25 points out that henequen containing pulp or more than 5 per cent. of dust, or that is wet or has rotted, will be considered and classified as "defective" for the purposes of these regulations.

Article 29 says that the Executive Government shall have the power temporarily to suspend the export of fibre graded as "C" and "C₁," and even to prohibit their export entirely.

CHAPTER VIII

THE PHILIPPINES

ABACA *v.* SISAL

BEFORE concluding the planting section of this work, we shall all welcome the following trio of photographs which we owe to the courtesy of the Bureau of Agriculture at Manila, and the various officials who always countersign the letters from there, which, however, makes the result none the less useful but all the more to be appreciated.

First of all come the two circulars, Nos. 98 & 99, which we will now reprint, as they will help us a little further on when we come to discuss the retting of abaca or Manila fibre and the risk, when it exists, of bacterial fermentation, with a resultant depreciation in the strength and quality of the fibre.

Circular No. 98.¹

PLANTING INSTRUCTIONS FOR MAGUEY AND SISAL.

CLIMATIC AND SOIL REQUIREMENTS.

Maguey and sisal are hardy, drought-resistant plants and withstand variations in soil and climate better than most other cultivated tropical plants.

Although the plants grow luxuriantly in a rich soil and a wet climate, the quality and yield of the fibre

¹ Both this circular and No. 99 have been reproduced by permission of the Government of the Philippine Islands.

under these conditions are not, as a rule, the best. A long dry season and a short rainy one may, on the whole, be considered essential for best growth of these plants and for the development of their fibre.

Well-drained limestone soils, with a considerable admixture of sand, are best suited for growing maguey and sisal for fibre production.

All low or swampy land in which standing water comes in contact with the roots, or in which the water takes a long time to run off, should be avoided.

PROPAGATION.

Sisal and maguey produce no seeds and are propagated by means of suckers and bulbils.¹

Suckers grow around the mother plant and spring from the underground runners, or rhizomes.

Suckers intended for planting should be dug up when they have attained a height of 15 to 25 centimetres and should be secured, if possible, from plants between four and six years of age. Trim off the

¹ This does not altogether agree with what Frank Conter tells us in his *Bulletin No. 4*, of 1903, where on p. 9 he actually illustrates a seed capsule, natural size, shaped like a large gooseberry, the capsule itself measuring nearly 2 inches besides which a thick stalk, as on a banana, runs into another $\frac{1}{2}$ in. On the previous page (p. 8) Mr. Conter speaks of the *Chelem*, the wild sisal plant of Yucatan, with detailed descriptions, and ends up by saying that from this, which may be termed the wild plant, the following cultivated forms have arisen. A list is then given, including *A. rigida sisalana*, and it is in the midst of the paragraph devoted to this variety that the photograph of the seed capsule has been placed. Does Conter infer that only this one variety bears fruit, for the following remark attached to *A. rigida sisalana* appears nowhere else as far as I can find. This is what he says: "The plants seldom bear fruit, but produce an abundance of adventitious shoots or bulbs by which they propagate themselves. Sometimes there occur seed capsules, the same size and shape as on the wild plant, see illustration above." If the wild sisal has seed pods why not the cultivated varieties, especially as, apparently, with the one kind in Hawaii, a seed capsule (produced in Hawaii) does appear?

older leaves around the base of the suckers and plant directly into the field.

Bulbils are produced on the branches of the flower stalk which grows from the centre of the plant at the time it reaches maturity.

The small bulbils which are produced on the branches of the flower stalk eventually develop into small plants eight to ten centimetres in length. These bulbils should be set out in a nursery for a period of six to eight months, or until they have attained a height of twenty to twenty-five centimetres, after which they may be transplanted to the permanent field. The nursery should be properly prepared and kept clean from weeds at all times. The young plants require no shade but should be watched occasionally until they have become well established.

PLANTING IN PERMANENT FIELD.

Where the land is arid and rocky, the suckers and nursery plants may be set out with but little preliminary preparation of the soil. If the land is overgrown with underbush or weeds, however, as most localities in the Philippines are to a more or less extent, then it becomes necessary to clear the land and burn the waste prior to planting.

If possible, the land should be ploughed and secondary crops raised, such as sweet potatoes, peanuts, lima beans, mongo, &c., provided care is exercised that such crops do not shade the young maguey and sisal plants or in any other way seriously interfere with their growth and development.

The suckers or nursery plants should be set out in straight rows, not less than 1.5 by 2.5 metres nor more than 2 by 3 metres apart (metre = $39\frac{1}{8}$ in.).

As a rule, the plants may be set out closer together in poorer than in richer soils, and sisal plants, on account of the strong rigidity of their leaves and the

absence of the marginal spines on them, may be planted somewhat nearer together than the maguey plants.

CARE OF PLANTATION.

If it is found practicable to plant secondary crops between the rows of maguey or sisal, the need for cultivation will, in a large measure, be done away with, as these crops will keep the interspaces quite thoroughly covered and smother out weeds and grass. However, as stated above, care must be exercised to prevent climbing plants, such as lima beans, from running over the young maguey and sisal plants and stunting their growth.

If no cover or secondary crops are grown, the plantation should be gone over occasionally and all weeds and wild growth cleaned out. Although it is true to a certain extent that maguey and sisal plants will thrive under conditions of neglect, it is also true that they respond very freely to proper cultivation and care.

Besides the necessary cultivation of the plantation to keep down weeds and other foreign growth, the periodical cutting or digging up of the suckers from around the mother plants is another operation which should receive attention from the planter.

The suckers should be removed as soon as they appear, for as long as they remain attached to the mother plant, especially before they have become old enough to send out roots of their own, they deprive it of a large part of its nourishment and induce its early poling, or the sending out of the flower stalk.

Circular No. 99.

PREPARATION OF MAGUEY AND SISAL BY RETTING.

At the beginning of the dry season all matured leaves—about fifteen to twenty leaves—from every

normal and matured plants should be cut. The marginal and terminal (with sisal only the latter) spines should be trimmed off in order to facilitate the handling and transportation of the leaves.

Care should be taken not to hurt or wound the leaves, while cutting from the plants or handling them, as cuts in the leaves will cause stains in the finished fibre due to the gummy substance present. Slit the leaves as soon as possible into strips and tie them into bundles.

Immerse the bundles in salt water, preferably in troughs made of reinforced concrete constructed for the purpose. The size should be about six feet in length by four feet in width and three feet in depth. An opening should be provided for at one end to facilitate the removal of water. The size of this trough can be made to vary according to the length of the leaves and the amount to be retted by the producer. A number of vats or troughs should be built to facilitate the handling of the bundles of slit leaves.

The bundles should remain in salt water for about eight or ten days, till the fleshy substance is fairly well decomposed. During this time the bundles should be turned a number of times to insure equal decomposition.

When the strips are sufficiently decomposed the bundles are taken out of the water, and the pulp is easily beaten and scraped off. Precautions should be taken to prevent fermentation, as this causes a poor grade of weak and discoloured fibre.

After the pulp has been beaten or scraped off, the fibre should be washed again with fresh water, preferably in a running stream until all traces of salt water have been removed. Care should be taken to see that all of the salt water is removed. The least amount of salt water left prevents thorough drying and deteriorates the strength of the fibre.

The fibre should be dried well in the sun after it has been freed from all traces of salt.

It should then be tied into hanks or bundles, the size of which should not exceed twelve centimetres in diameter, nor be less than six centimetres ; and classified according to the standard grades as prescribed in the Fibre Law and the regulations of the Bureau of Agriculture.

Compare the above with the following notes on the preparation of abaca or Manila fibre from the well known *Musa textilis* in the Philippine Islands, especially with reference to the effect of retting on the fibre, and how by allowing the rotting stems to remain on the ground, bacteria trouble is encouraged which can also have a harmful effect to the resultant crop. About the same time that I was writing across for information from Manila, the *Journal of Science* that is published over there came to hand, viz., Vol. xxxvii, No. 1, for September, 1928, and it contains two articles concerning abaca or Manila hemp which will probably interest my readers, especially with regard to the harm that can accrue by the refuse lying on the ground, whether from sisal, i.e., agave plants, or Manila, i.e., musa stems, either on the fibre-producing estates in those islands or elsewhere. It must be the same with the fruit on banana plantations, to which I have been calling attention for some time.

It is a pity that the whole of the 65 pages devoted to the subject of abaca production in the above *Journal* cannot be reproduced here, but such a thing is of course impossible. Taking the first article, however, Dr. P. L. Sherman, Cordage Institute Fellow, Bureau of Science, Manila, discusses abaca soil conditions in two districts of the Philippines, and the relation of these conditions to the fibre produced.

"The investigations and the experiments outlined in this paper," he says, "were made with the object

of throwing light on what probably has been and undoubtedly will continue to be the most serious trouble connected with abaca production, viz., weak fibre. It is fundamental that plant growth is determined by the kind and the amount of the chemical substances furnished through its roots, and by the conditions of moisture and climate. Serious disturbance of normal growth may result, consequently, from any change of normal conditions. This disturbance is generally manifested by disease or abnormal products, and in the case of abaca apparently by diminished resistance to disease and a weak fibre of short durability in place of the strong, lasting fibre known all over the world.

“Analysis of abaca discloses two distinct kinds of chemical constituents : inorganic, or the mineral salts taken from soil moisture by the roots ; organic, or the material furnished both by the roots and by the photosynthesis of the plant itself in the leaves. These two kinds of chemical constituents combine to make the complex chemical bodies that supply the materials for plant growth and development.

“Summing up the results of the investigations made we are reminded that for the most part present conditions in the abaca areas of the islands are of long standing rather than new or novel. We are thus reaping the results of the omissions and commissions of the abaca growers for the past fifty years, and these have been brought into prominence on account of the scientific developments of most of the other branches of the industry after the fibre has been produced.

“This production of the fibre is unique by the fact that the soil is made to produce the same crop for an indefinite period without either ploughing or cultivation being practised, except in one district (probably that of Davao), where the benefits of the modern practices of production are shown by the relatively better condition of the soil, the increased yield of fibre per

acre or hectare, and the uniformly high quality of the fibre. Again, going back to the more backward areas, no fertilization or manuring of the soil has been attempted beyond the addition of the large quantities of abaca waste (without apparently any treatment whatever) which are left to ferment in the field after the fibre has been harvested.

“The results of such a practice are : on the soil, a steady and heavy exhaustion of the necessary plant food minerals, and the consequent permanent acid condition. On the plant there is a lack of essential mineral salts, on which the plant depends for its proper growth and development as well as for its maintenance of normal resistance to disease. This is indicated by the low average yield per acre or hectare of the older producing districts, whilst on the fibre itself there is an excess acidity that always produces short durability and an enforced substitution of the necessary salts by inferior ones, which results in a loss of tensile strength, the one quality of the fibre which dominates above everything, even above its length and lustre.”

In the next article the two Shermans (you will again meet them on p 355) then go on to discuss the tensile strength of abaca fibres in relation to their acidity. This paper, the report starts by telling us, speaks of the experiments performed at the Bureau of Science, Manila, in the attempt to discover : (1) What relationship exists between the tensile strength of a sample of the fibre and the amount of acid present; and (2) whether there is any mathematical connection between speed and amount of loss of tensile strength of an abaca fibre sample during storage and its acid content.

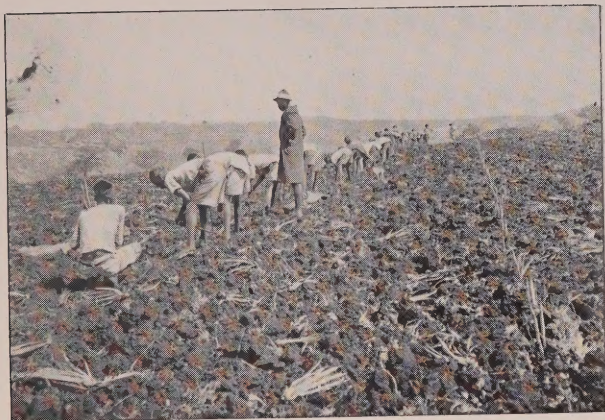
Summing up, we are told that the natural acid content of abaca is greater in fibre having low tensile strength, also that the loss of tensile strength in abaca

during storage is affected by the acid content, but as yet no definite mathematical relationship between the rate of loss of this tensile strength and the acid content has been discovered.

Moving on to the question of fermentation as affecting the quality of the Philippine abaca fibre, Dr. P. L. Sherman, this time in collaboration with Mr. Trinidad Bañuelos, the assistant bacteriologist at the Bureau of Science, has much to tell us, and we have here an article which surely everyone should know by heart, whether they are growing bananas for food, or sisal or Manila hemp for cordage, since they discuss in detail the danger of leaving rotting, fleshy vegetation to decay on the field round the living plant, heedless of the terrible mischief from bacteria, &c., that they are laying up for their plants as well as for themselves.

The reduction, Bañuelos and Sherman tell us, when discussing abaca preparation, of vegetable matter containing cellulose, carbohydrates, proteins, woody matter and inorganic salts to available plant foods, is chiefly brought about by the micro-organisms called bacteria, often assisted by fungi commonly known as mold. The differences between the bacteria and fungi, both causing deterioration and decay, are many and well marked. The fungi, generally speaking, are plant-like in structure, being supported on appendages resembling roots and reproducing very rapidly by means of spores, though their growth and multiplication are measured by days rather than by hours and minutes. On the other hand, bacteria are a much simpler form of vegetable life, in that they have no root-like supports; many kinds, in fact, are even motile and reproduce by division, each new entity redividing as often as one every ten or fifteen minutes, under favourable conditions such as are furnished by the pulpy residual trunks from which the fibre layers are stripped, and

PLATE XI.



Planting out sisal, Philippine Islands.



By courtesy *Bureau of Agric., P.I.*
Sisal at La Carlota Experimental Station (1913), Philippine Isles.

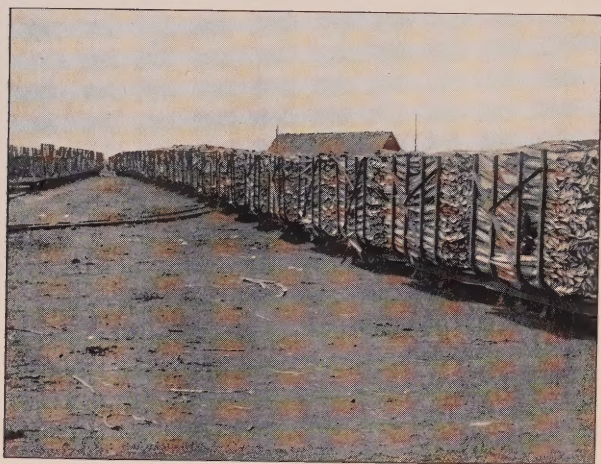
PLATE XII.



By courtesy

Bureau of Agric., P.I.

A neglected sisal plantation, Philippine Islands.



Transport.

A train-load of sisal outside the factory and (*left*) empty cars waiting to go back.

even by the freshly-stripped, juice-saturated fibres themselves.

So fast working and complete is this bacterial action in all countries producing hard fibres, to which the many varieties of hemp belong, that it is made use of to free the fibre bundles from the pulpy, cellular matter surrounding them. In the Philippines the entire sisal and maguey crops are prepared by this fermentive process, known as "retting," the vital points of which—still quoting Bañuelos and Sherman—are as follows:—

(1) Great care in allowing the process to progress only far enough to soften and disintegrate the extraneous vegetable matter without acting on the fibres themselves, for, though the fibre is quite resistant and the last (of the mass) to soften and disintegrate, it will do so eventually.

(2) Careful cleaning and washing of the retted fibres to free them of the still clinging, cellular matter, and especially to eliminate the acids formed through fermentive action, as these acids are recognized everywhere as the great destroyer of all kinds of vegetable fibre.

(3) Careful thorough drying of the retted fibre after the washing is completed¹ in order to kill all bacterial and other micro-organisms still clinging in countless numbers to the wet fibre. Long and costly experience has shown that this is the cheapest and best way of ensuring long life and durability to the retted fibre.

There is much more that one would like to reproduce, but it would not be fair to the experts to whom we owe the information to do so.

The fresh fibre as it comes from the stripping knives

¹ See p. 196, where Mexico seems to think it an advantage not to wash their sisal.

in Manila is so saturated with plant juices that even hand pressure is sufficient to expel them, and all of the chemical constituents that they contain consequently dry into the fibre during the drying process that follows.

How do the effects of the present method of extracting sisal fibre and the subsequent "handling" of the refuse compare with this description of what goes on in the Philippines? With abaca it seems the drying process is of the utmost importance to the future strength and durability of the fibre, and this is shown in the report that we are now discussing; yet no drying sheds are ever provided, the fibre being dried in the open, as is the case with the bulk of the sisal produced, and is thus subjected to all the vicissitudes of a tropical wet climate, whilst the drying consequently requires anything from two hours to two weeks. Furthermore, the planter has to remember that the fibre when promptly and well dried is in its best possible physical condition to perform its allotted commercial functions, which are to maintain its tensile strength, its colour, and its resistance to wear for a reasonably long time.

Again one would ask, how does the preparation of sisal fibre compare with that of abaca, when we remember that both are vegetable in their origin and that the latter is, to a large extent, composed of cellulose, with which is bound up a rather large number of chemical substances, both organic and inorganic? These in their entirety constitute the true fibre body, and through their varying amounts and combinations give rise to the many grades now recognized commercially. To determine how, when and why abaca fibre became weak and discoloured, i.e., became damaged and perished, deserves the closest attention and is the object of various investigations now being reported on.

As has already been mentioned, when stripping

abaca, some 85 per cent of the plant as felled for stripping is left on the ground after the fibrous layers have been removed, and there it lies amidst the growing and immature plants, where it promptly ferments and decays, even if, in the course of a few months, it is absorbed by the soil and used as a new plant food. Be this as it may, there is no gainsaying the fact that the growing plants are always surrounded by fermenting material with its many active agents of fermentation that can and do bring so much harm at times. In the summing up, therefore, one is not surprised to be told that in the immediate locality where all the fibre is recovered and stripped, there is a hotbed of bacterial infection, and all commercial fibre produced is heavily infected with this bacteria, which is diversified, large and active. Failure to dry the fresh fibre promptly and thoroughly, or re-wetting it after being once dried, results in fermentation, the immediate effects of which are the production of increased acidity, the lowering of tensile strength, a change of colour and a decrease of lustre; in other words, it shows all that which characterizes defective and poor fibre, and these effects appear to be caused by the acid fermentation products of the soluble constituents of the fibre as well as by the direct action of the bacteria brought into being.

Are there not many points to be learnt and pondered over by sisal planters, after studying the above, however different the abaca plants may be to that which produces the fibre known as the sisal of commerce?

* * *

In conclusion some may like to take note of the following table. In any case its presence can harm no one and may help a few.

The "Grading of Manila Fibre in the Philippines—Official Classifications in Use," taken from the Special Fibre Number of the *Philippine Agricultural Review*,

probably Vol. XVI, No. 2, of 1923, of which Part IV, p. 74, contains the following table. (Owing to damaged notes, these references cannot be guaranteed, but the following table is all right):—

THE GRADING OF MANILA FIBRE.

Letter designation	Name of grade			Old names and qualifications
A	Extra Prime	...	...	F.E.A. quality, 100 per cent. over good current (see D)
B	Prime	...	...	F.E.B. quality, $62\frac{1}{2}$ per cent. and 75 per cent. over good current
C	Superior Current	...	...	$37\frac{1}{2}$ per cent. and 50 per cent. over good current
D	Good Current	...	...	Good current and 25 per cent. over good current
E	Midway	...	...	Midway or 50 per cent.; $62\frac{1}{2}$ per cent. and 75 per cent. over fair current U.S.
S ₁	Streaky, No. 1	...	...	Leyte superior seconds
S ₂	Streaky, No. 2	...	...	Leyte good seconds
S ₃	Streaky, No. 3	...	...	Leyte fair seconds
F	Current	...	...	25 per cent. and $37\frac{1}{2}$ per cent. over fair current, U.S.
G	Seconds	...	...	Soft and medium seconds, U.S.
H	Brown	...	...	Soft and medium browns, U.S.
I	Good Fair	...	...	Fair current and $12\frac{1}{2}$ per cent. over fair current, U.S.
J ₁	Fair No. 1	...	...	Superior seconds, U.S., and 50 per cent. over superior seconds, U.S.
J ₂	Fair No. 2	...	...	Fair current, U.K., and superior seconds, U.K.
K	Medium	...	...	Medium browns, U.K., and fair seconds, U.K.
L	Coarse	...	...	Good seconds, U.K.
DL	Dark Coarse	...	...	Dark current and dark seconds
DM	Dark Coarse Brown—Dark Reds			
O	Strings—white and fine			
OO	Strings—dark and coarse			
T	Tow—white and fine			
TT	Tow—dark and coarse			
Y	Damaged—fine fibre			
YY	Damaged—coarse fibre			
W	Waste			

CHAPTER IX

HAWAII

ONE must stop reminiscing or making notes from past reports now out of print because, although we have been starved too long for want of a useful work on sisal, so much has been published in the past, if not recently, that a book with a planting section alone of 400 or 500 pages could be filled without exhausting all that has been said and written on the subject. Before breaking off, however, let us take extracts from what Mr. Conter—(Frank E. Conter, Assistant at the Agricultural Experiment Station, Hawaii)—had to tell us, also early in the century, viz., in 1903. In the original MS. this section was headed, "Sisal-planting in Hawaii," but for reasons plainly obvious to those reading what I am about to say, the heading has been changed to the above.

The sisal industry was probably started in Yucatan by the Toltecs, who emigrated from Central Mexico to Campeachy about A.D. 1060, or just before William the Conqueror and his barons migrated to England. In 1832, Dr. Henry Perrine, U.S. Consul at Campeachy, gave the name *A. sisalana* to two varieties, viz., *yashqui* (greenish) and *sacqui* (whitish). Four years later, i.e., in 1836, Dr. Perrine introduced the *yashqui* or greenish variety into Florida, and in 1893 the Hawaiian Commissioner of Agriculture and Forestry ordered 20,000 sisal plants from Messrs.

Reasoner Bros.,¹ of the Royal Palm Nurseries at Oneca, Florida, which were carefully set out in Hawaii, first at the experimental station and then elsewhere on the sugar and other estates.

Dr. Perrine, in his report to Congress (February 17, 1838), stated that the soils round Merida, Yucatan, were composed of arid, cavernous limestone, and that in the whole region there was not a single running stream. Dodge, i.e., Charles R. Dodge (in the *Scientific American*, Sup. No. 1837 of August 2, 1902) over sixty years later spoke of the same area as being barren of soil, the sisal being "planted" in many cases by being propped up into place and held there by small stones or stuck into the crevices in the coral rock; in spite of this—can one say, because of this?—it grew and flourished. The adaptability, Conter points out, both of Yucatan and the Bahamas to the cultivation of sisal is apparently due as much to the climatic conditions as to the soil; in other words, the proximity to the sea and high temperatures with low rainfall, are quite as essential to the plants as suitable soils.

'Proximity to the sea'—this phrase recalls to mind the coconuts on the seashore which are said to languish if planted inland.

With so marked a scarcity of water in Mexico, one wonders how the old-time *henequeneros* did with regard to washing the fibre, since modern reports all speak of the need of a good supply of water for the factory. Perhaps this is why, as can be gathered in the section dealing with Mexico, "Yucatan does not wash the fibre," claiming that unwashed fibre is best (p. 196).

¹ This firm still flourishes, for I received letters from the son and nephew of the founders whilst reading the first set of proofs for this book. Whether the present management is interested in sisal, however, I cannot say.

In Hawaii, the famous Ewa sugar plantation was one of the first to plant out sisal on its worst soil. One wonders whether there is any there to-day. Conter urges planters to see that their nurseries are protected from strong winds and have good, well-drained soil. All brush and weeds must be removed and the soil carefully cultivated. A supply of water should be provided—how unlike Yucatan, at any rate of old. The plants may be placed 9 in. apart in rows of 18 in. apart. They must be cultivated, kept free of weeds, and watered with hose or can, if necessary, but never irrigated.

One-year-old plants will, with proper treatment, be 18 in. high, and may then be transplanted to the field. Three years later, i.e., when the plant is four years old, the lower leaves assume a horizontal position and show other signs of maturity and of being ready for the knife. Great economies will ensure, or loss be incurred with suitable or unsuitable transport facilities. Mr. Conter gives much information and quotes many authorities on the number of leaves and consequent yield of fibre per plant and acre, but even if such information still holds good, lack of space prevents the inclusion of so many opinions here, and to give one and not all the returns might be misleading. It may be useful, however, to reproduce in full the following extract from the article by Mr. Dodge in the *Scientific American* of August, 1902, already referred to, if only because it leads up to a mention of the plants in Yucatan as yielding when even fifty or sixty years of age, or nearly ten times as long as elsewhere. This is what Mr. Dodge wrote:—

“ From the age of five years and upwards—from the date of transplanting to the time when the plant blossoms and dies—twelve to fifteen leaves may be taken annually for the extraction of fibre. These leaves are about 4 ft. 6 in. long, 4 to 5 in. wide and $\frac{1}{4}$ in.

(one-quarter inch) thick They weigh from less than 1 lb. to over 2 lb. each. In Yucatan, the conditions of soil and climate are such that a plant may live to be twenty, twenty-five or even thirty years old before blossoming, while some, it would appear, never blossom, as very old fields were seen by the writer (Mr. Dodge) where the plants were simply drying up and dying of old age.

"In this question of the longevity of the plant is involved a dollars and cents proposition. If the leaves of a plant as they develop can be annually cut until the plant reaches the age of twenty years before blossoming, it means, at any rate in Yucatan, that an annual crop of leaves may be taken for fibre-production during a period of fifteen years. A fifteen-year-old plant in Yucatan has not only developed a definite 'trunk,' but successive annual cuttings of the leaves add to the length of that trunk,¹ so that the leaves, instead of spreading out near the surface of the ground, are produced at the height of a man's head."

These Yucatan fields, Dodge goes on to say—spelling the crop with a "j," i.e., jenequen—"commence to yield in the fourth or fifth year after being stocked, and continue to do so for fifty to sixty years, and even longer." No wonder, therefore, if such things still exist, that we find it difficult to compete with Yucatan in production costs.

¹ See illustration, p. 193, of Mexican Section.

CHAPTER X

JAVA AND SUMATRA

HEARING more than one report of important expansions in the areas being planted with sisal in Sumatra and Java, I wrote to friends out there but received no reply. On this side however, when discussing the matter with those in close touch with the islands, I was told that no such expansion is taking place, and that the combined output of fibre (mainly sisal) from the Dutch islands amounted to 47,573 tons (ton=2,240 lb.) in 1928, against 44,114 tons in 1926 made up roughly as follows:—

		1928 Tons		1927 Tons
Java and Madoera	...	20,869	...	16,347
Sumatra	...	26,704	...	27,767
Total	...	47,573	...	44,114

These returns include both *A. cantala* or *cantula* as well as *A. sisalana*, and also Manila hemp, *Musa textilis*, as grown in the Philippines. This latter is being cultivated, it would seem, on the lands of the "Amsterdam" Company, but unfortunately separate returns have not been forthcoming in time.

Possibly the combined output in 1929 will be under rather than over the figures for 1928, and in any case, whilst Java, with Soekamandi Estate (in English hands), first looked upon as one of the best, some say *the* best equipped sisal estate of to-day, and the famous "Amsterdam" Company (the H.V.A.)—well known because of its aversion to publish returns either

of its output of palm oil or sisal, &c.—has well-arranged and up-to-date factories, yet it would seem neither of these concerns is in a hurry to increase its areas under the crop, however willing they may be to increase the output from areas already planted.

Soekamandi Estate has always interested me as being the first sisal estate, as far as I know, to adopt centrifugals and band-carrying dryers for the fibre, instead of putting it out on lines in the sun or the air to drain and dry.

One set of returns of the (sisal) exports from Java was drawn up as follows, without any definite mention of Sumatra, unless that large expanse comes under the heading of "Other Islands" and is coupled up with Bali, Lombok, Soembawa, Flores, &c. In any case here are the figures supplied by Mr. Hutchence of the Netherlands E.I. Chamber of Commerce in London.

Tons of 1,000 kilos		1927 Tons		1926 Tons
Java and Madoera	...	18,329	...	16,489
Other Islands	...	28,780	...	21,839
Total		47,109	...	38,328

The Java and Madoera output was divided up thus:—

Tons of 1,000 kilos		1927 Tons		1926 Tons
Sourabaya	...	9,575	...	10,792
Tandjong Priok	...	3,791	...	1,493
Samarang	...	3,565	...	3,146
Elsewhere	...	1,398	...	1,058
Total		18,329	...	16,489

The following tables may come in useful, so let us include them as well:—

Sisal Exports:—

		Java, &c. Tons		Sumatra, &c. Tons		All D.E.I. Tons	v.	African Tons
1923	...	14,293	...	11,426	=	25,719	v.	25,012
1924	...	15,711	...	16,198	=	31,909	v.	33,627
1925	...	15,691	...	19,320	=	35,011	v.	37,598
1926	...	16,489	...	21,839	=	38,328	v.	47,095
1927	...	18,329	...	28,780	=	47,109	v.	49,669

East Africa :—

		Kenya Tons		Tanganyika Tons		Nyasaland Tons		Total Tons
1926	...	14,918	...	22,619	...	529	=	38,066
1927	...	15,855	...	31,375†	...	802	=	48,032
1928	...	16,516	...	36,186	...	1,162	=	53,864

† One return says 33,012 tons.

From "East Africa of To-day" (1928).¹ I have borrowed the following tables from an article by Mr. Alfred Wigglesworth, who also touches on the question of spacing when he tells us: "Considerable diversity of opinion reigns as regards the number of plants per acre; these vary from 600 in areas with rich soil to 1,200 in coastal districts. Certain estates have experimented with plants in double rows, 2,600 to the acre, a system which is preferred in the Dutch East Indies."

EXPORTS FROM TANGANYIKA.

(Under German Rule.)

		Tons			Tons
1900	...	7	1907	...	2,802
1901	...	45	1908	...	3,896
1902	...	177	1909	...	5,284
1903	...	422	1910	...	7,228
1904	...	764	1911	...	11,212
1905	...	1,140	1912	...	17,079
1906	...	1,820	1913	...	20,834

(Under British Rule.)

		Tons			Tons
1921	...	7,923	1925	...	18,276
1922	...	10,224	1926	...	22,619
1923	...	12,845	1927	...	31,375
1924	...	18,428	1928	...	36,186

In the *Bulletin*, published by the Department of Overseas Trade in which are discussed the "Economic Conditions in the Netherlands East Indies," to October 31, 1928 (price 3s. net), we are given the following particulars (p. 80), but they are no guide at all as to the real areas planted and crops secured, as the Dutch Government does not find it necessary to compel

¹ John Bale, Sons and Danielsson, Ltd.

everyone to make returns, and so, if the chief producer, to say nothing of the smaller concerns, does not choose to send in returns, we can take it that the figures are quite misleading since they might show only $33\frac{1}{3}$ or 50 per cent. of the total production. As it is, anyone who has even a faint idea of what is being done throughout the D.E.I., especially by one company, will want to laugh at the following returns :—

			1	2	3	Crop—1927	
						Tons	
Sisal ...	...	...	22	7,870	5,208	...	6,571
<i>A. cantala</i> ...	...	...	16	6,491	4,430	...	8,705
Manila hemp	...	...	2	392	319	...	236

1.—Number of Estates.

2.—Area planted (in hectares = 2'47 acres).

3.—Area producing (in hectares).

In marked contrast to the above we are told on p. 44 that doubt has existed as to whether or not Manila hemp is being grown in Sumatra, but it now appears to be established that experiments in its cultivation have been going on for some time. As the Dutch-owned estates in Sumatra however, have published no returns, and what figures are published show all kinds, sisal, cantala (or cantula) and Manila, to be bulked, one can only guess at the proportions of each. It is said on this basis that during the eight months, January to August (1928), 33,140 metric tons of fibre were exported against the ridiculous total given above of 15,512 tons for the whole of 1927. Furthermore no one can say whether those 33,140 metric tons are for Sumatra alone, or whether the 15,512 are supposed to be the output for all the estates making returns in the whole of the Dutch East Indies. One can smile at all this, but it is well to remember in these days when so many are averse to see increased acreages put under sisal, that the Dutch planters in the Netherlands have no idea of

restricting *their* outputs, either of sisal or rubber, whatever British producers may wish to see done. This being the case, let us watch developments over there and not imagine that our competitors will stand still because we may want to do so for a time.

Discussing the matter with Mr. Nathan, of Messrs. Francis Peek and Co., Ltd., the representatives of the Anglo-Dutch Plantations, who own Soekamandi Estate, he gave me to understand that of the (so-called) sisal of Java, i.e., the sisal produced in Java and Sumatra, the total exports for the last two years have been as follows :—

		1927 Tons		1928 Tons
Java and Madoera	...	16,347	...	20,869
Sumatra	...	27,767	...	26,704
Total	...	44,114	...	47,573

The Dutch East Indies Customs give figures of export for "fibres" only, so that the above figures include both *cantala* and *abaca*. The export of *cantala* may be taken as roughly 1,500 tons, but it is not possible to make an estimate of the *abaca* exported from Sumatra. The largest producer of sisal in Java and Sumatra is the Handels Vereeniging "Amsterdam," and the second largest the Anglo-Dutch Plantations of Java on their Soekamandi estates. These two companies account for over three-quarters of the total production, the remaining one-quarter being grown on about twelve smaller estates.

All the sisal in Java and Sumatra is grown on well-equipped European estates. There is no native production and the manufacture or preparation of what is produced has reached such a pitch of excellence that Java sisal commands a considerable premium over any other. This is shown by the fact that, in the *American Cordage Trade Journal* of February 7, 1929, the best grade of Java sisal was

quoted one cent per lb. above No. 1 African, and three cents per lb. above Mexican sisal. To-day it is America and the Continent of Europe which take practically the whole of the Java sisal production, with the exception of about 3,000 tons shipped to Australia. Imports into the United Kingdom are negligible, manufacturers being unwilling to pay the premium on these fine grades (the superiority of which lies in their whiteness and gloss), which is obtainable on the Continent and in the U.S.A., where the buyers realize that good looks do not alone count, for the D.E.I. produce also challenges comparison with any other sisal in respect of length and tensile strength. Owing to this, it is in great demand in America, especially for the manufacture of shop twine. During the past few months, a very large shipping company in Liverpool has experimented with rope made partly of Manila hemp and partly of Java sisal (Soekamandi mark). Tests have been carried out as regards breaking strain, actual stevedore work, actual use on board ship and actual use for towing. On the first three of these tests the reports have been extremely favourable; the fourth test has not yet been completed as none of the towing rope so manufactured has so far given out. There seems every probability, therefore, that the use over here, as well as elsewhere, of Java sisal in rope manufacture will increase.

CHAPTER XI.

*CUBA.*SISAL GROWING FOR CUBA.¹

Writing in the *Cuba Review* (an illustrated monthly magazine, published from 67, Wall Street, New York City) for January, on "Henequen, the Rainbow of Hope, Development of a New Industry, viz., Sisal Production in Cuba," Mr. George Reno gives much information that is new to most of us concerning what he claims to be the tactics in Yucatan when handling their output and of the efforts of leading men elsewhere to skirt round those tactics by growing the supplies they need outside Yucatan, including Cuba.

At first we only intended calling attention to this article, but having allowed the time to pass, and finding all that Mr. Reno has to tell us of such interest, with many apologies to our contemporary for doing so without first asking their permission, we have decided to print the article in full. Leaving out the quotes, this is what Mr. George Reno has to tell us:—

CUBA AND HER EXPORTS.

Those who are interested in the welfare of Cuba have long lamented the fact that, up to the present at least, this is largely a one-crop country. Sugar is king and has been for more than half a century, with

¹ Reproduced from *Tropical Life*, September and October, 1925, as likely to prove of exceptional interest, since the price of Cuban sugar to-day being below 2 cts. per lb. c. and f. New York (April 15, 1929), should encourage sisal production over there.

tobacco a poor second. From the cultivation of cane and the conversion of its juice into sugar we are deriving some \$400,000,000 annually, and this forms by far the greatest source of our income, it is, in fact, the life blood of the Republic. Tobacco yields us approximately \$40,000,000, a large part of which is consumed at home and so gives us little to sell abroad. And in the tobacco industry, too, we have strong competition in the United States.

Next in the order of exports we have copper, iron and a few other minerals which bring us a return of some ten or twelve million (dollars). From this we drop down to less than half with the export of pineapples, citrus fruits and vegetables, which yield four or five millions. Trailing along come hides, honey, beeswax, hard woods, &c., with some three or four millions. But from the above figures it may be readily seen that our national revenue, our source of commodities which can be exchanged for cash in the outside world, is confined very largely to sugar. Why so? This in any country is unfortunate, but in Cuba, although the climate and rainfall are most dependable, if by chance we meet with a bad season or a period of low prices prevails in the sugar markets of the world, Cuba must undoubtedly suffer serious loss, if not economic disaster. What can be done to remedy such a state of affairs.

SISAL TO THE RESCUE.

Men who are familiar with the conditions and interested in the commercial future of the island realize the danger, and have long sought some agricultural industry that could be developed on a large scale within the limits of the Republic, and thus form a running-mate for our chief industry, sugar—something that would furnish us a line of defence in case of accident to the one great crop on

which we at present rely for our source of national revenue. Such a case, we believe, has at last been found in the cultivation of the plant known as henequen and the conversion of its fibre into sisal, a product for which there is an unlimited demand throughout the United States and Canada, and which will probably find ready sale when made up into binder-twine in all sections of the world where grain crops are produced in large quantities.

Up to ten years ago, or more accurately, until the beginning of those revolutions which brought about the downfall of Porfirio Diaz, Dictator of Mexico, a single Province of that unfortunate Republic furnished the world with sisal derived from the henequen plant that was indigenous to Yucatan. The development of this industry made Merida famous as the city of millionaires, a reputation which might have been enjoyed indefinitely had it not been for the almost continual revolutions that swept over Mexico, rendering the industry practically impossible.

THE DRAWBACKS IN YUCATAN.

As an illustration of the extent to which the sisal industry suffered in Yucatan, it may be mentioned that only a few months ago (in 1924) one of the largest cordage manufacturers in the United States sent agents to Merida, where they finally succeeded in purchasing direct from growers of henequen and manufacturers of sisal, a sufficient amount to justify the sending of several vessels for the fibre. The material was paid for, and after many difficulties was finally gotten aboard the steamer, when the officials of those days in control of the ports of Yucatan sent officers and soldiers on board with instructions to see that the said cargoes of sisal did not leave Merida. And there it still lies, awaiting diplomatic action, and will undoubtedly result in heavy damage if not total loss to the purchasers.

DON TERESA COMES TO CUBA.

As may readily be seen, this condition of affairs became so discouraging that many producers abandoned the business. Some of them came to Cuba to look over the ground and study soil conditions with a view to starting the sisal industry in this Republic, lying as it does in the same latitude and only 100 miles distant. Among these early pioneers who have devoted most of their lives to the cultivation of henequen in its native soil, but who, for political reasons, had been compelled to leave Yucatan, was Don Antonio Teresa. He with several associates purchased land near the city of Neuvas and there started a plantation which, under their skilled management, soon became a pronounced success. But these men, arriving in Cuba with comparatively little capital, worked at a disadvantage, since they were unable to secure modern machinery with which to convert their leaves into sisal. But they devoted their energies to extending the plantation as rapidly as possible, which was easy since each mother plant sends up from six to twelve suckers every year, and these form the most costly item in starting the sisal industry. With crude machinery, however, they succeeded in decorticating their fibre and baling it for export, but not to their satisfaction.

EARLY DAYS OF SISAL IN CUBA.

Long before this, however, one of the governors of Cuba during the Spanish régime succeeded in getting a few plants from Yucatan which were set out in the eastern end of Cayo Romano, some forty miles west of Nuevas. From this nucleus several thousand suckers were afterwards purchased and carried by two German residents to the city of Matanzas, where they were planted on the hills that face the harbour

These, through the rapid multiplying of the suckers, soon formed a large plantation, the owners of which established the present cordage factory which for some time past has supplied the home market of the island with most of the rope and binding twine used in this Republic.

AMERICA TAKES A LOOK ROUND.

At the beginning of the European War the International Harvester Company and binding twine manufacturers of the United States, realizing the hopeless conditions of the sisal industry in Yucatan, dropped an anchor to windward by purchasing several large areas of henequen land between Matanzas and Cardenas, forty miles farther east. Since then the big firm has purchased several thousand more acres north-west of the city of Cienfuegos, where henequen is being planted for future use. With these additional plantations they are evidently endeavouring to become independent of Mexico for their supply of sisal.

In the meantime other manufacturers of cordage in the United States became anxious in regard to the future supply of sisal for their factories. Some three years ago Mr. George H. Simon, one of the directors of the Plymouth Cordage Company of Massachusetts, the second manufactory of cordage in the world, called at the Bureau of Technical Information in Havana to discuss the possibilities of henequen growing in Cuba.

Mr. Simon is the foreign field agent for his company, and is probably the best informed man in America in regard to sisal production and raw material for cordage manufacture of all kinds.

He had just come from Mexico and was anxious to get information in regard to the various sections of Cuba where the soil might be adapted to henequen culture. He told me frankly that his company, with

its factories in New England and Canada, was worried in regard to the production of sisal, on which they were dependent for the continued manufacture of cordage. I indicated several localities throughout the island which, in my estimation, were well suited for henequen culture and he at once ordered the company's soil expert to join him in Havana.

MR. SIMON GETS IN TOUCH WITH TERESA THE
PIONEER.

Mr. Simon soon got in touch with Antonio Teresa, already mentioned as the founder of a henequen plantation near Nuevitas, and who is probably the best-informed man in this country in regard to henequen growing and fibre extraction. Together these gentlemen went to Camaguey and there made a careful study of the soils, subsoils and all of the various factors essential to sisal production. Mr. Simon was very much pleased with what he saw, and so reported to his company in Massachusetts, where he urged them to follow the lead of their competitors and invest capital in Cuba, at least to a sufficient amount for demonstration purposes.

This was done last spring (i.e., in 1924) when the Plymouth cordage people organized a subsidiary company in Havana, known as the Spanish American Cordage Company, and purchased the Teresa property at Nuevitas, where they have established the most up-to-date type of sisal industry at any centre. Special machinery was brought from Yucatan and installed with electric power and oil engines for emergencies. The plant was put up by the inventor, who came on from Merida. In its capacity as a single unit 100,000 leaves are defibred every day and the sisal baled in packages of 450 lb. each, ready for shipment to Boston.

THE BAY OF NUEVITAS FOR SISAL LANDS.

The soil surrounding the Bay of Nuevitas is excellently adapted to the culture of henequen, and the rendition, in both quantity and quality of fibre, exceeds all known records, running far ahead of anything spoken of in Yucatan. The net returns per acre of henequen are far in excess of profits that are known to accrue from the cultivation of cane and the manufacture of sugar. This is not only gratifying to the Plymouth Cordage Company, but of great importance to the agricultural future of Cuba.

During the installation of decorticating machinery on the Nuevitas plantation and the extension of their plantings in adjoining lands, the Bureau of Technical Information in Cuba instituted a campaign of exploration throughout the Republic in order to ascertain the possible amount of land whose soil and location would permit of henequen culture under favourable conditions. These conditions are essential to success and cannot be ignored. The result has been a demonstration of the fact that we have in Cuba not thousands but millions of acres of land far better adapted to henequen than anything ever found in Yucatan, the original home of this marvellous fibre plant.

THE SECRET OF CUBA'S SUPERIORITY.

The secret of Cuba's superiority as a sisal-producing country rests on the following facts : Our top soil is richer, our limestone strata are softer, and our rainfall is eight times as great, while our facilities for rapid and cheap transportation are infinitely better. Then, again, our labour is abundant and is not dominated by the labour agitators of Eastern Mexico.

The true henequen plant, or the sisal producer of commerce, will grow in any good soil in Cuba, but in order to have a strong fibre, its roots, at a depth

not to exceed 6 or 8 in., must find a resting place on soft limestone rock. In lieu of this underlying limestone ledge, a liberal amount of pebbles or broken pieces of lime rock will suffice, but land devoid of this factor will not yield a plant of strong fibre.

Fortunately for Cuba and the binder-twine industry, nearly all our mountain chains and foot hills are composed of limestone ledges that were, at some time, thrown up from the deep sea floors of the Caribbean and the Gulf of Mexico. All we have to do is to utilize them. And again, fortunately, these lands of shallow-top soil have not sufficient depth for sugar cane, and therefore are comparatively cheap, as nearly all valuations of land in Cuba are based on their ability to produce good cane.

THE PRICE OF SISAL LANDS IN CUBA.

Henequen lands in Cuba may be purchased to-day (1925) at from \$20 to \$30 per acre, while cane lands have cost from \$40 to \$100. This disparity, however, in the price of lands will probably not long continue, since estimates based on the initial capital required for the installation of sugar mill estates, the cultivation of cane and the making of sugar, when compared with the cost of placing the same area in henequen, and the production of fibre, with the resulting profits per acre, seem to be decidedly in favour of the sisal industry. A few figures will illustrate this.

The capital required for a sugar estate of ten thousand acres operating in Cuba will approximate \$5,000,000. Such an estate, under favourable circumstances, with a rendition of 11 lb. of sugar to 100 lb. of cane, should yield 82,500,000 lb. of sugar. This crop sacked, loaded on board steamer at a Cuban port, and sold at $3\frac{1}{2}$ cents per lb., would bring \$2,887,500. Calculating the cost of the sugar at

1½ cents f.o.b., or \$1,237,500, there would remain a difference or return of \$1,650,000, which sum, divided with the colono or grower of the cane, leaves a net profit to the mill of \$825,000, or 15 per cent. on the invested capital of \$5,500,000. [These figures of course must now be reduced.—H. H. S.]

THE CAPITAL REQUIRED AND YIELDS OBTAINED.

The same area of land, ten thousand acres, purchased at \$22.50 per acre, cleared, prepared and planted with 9,900,000 henequen suckers at \$150 per thousand, together with necessary defibering machinery at \$160,000, \$370,500 for preparation and installation, \$189,900 for care and cultivation during three years, and \$250,000 for working capital, will represent an investment of \$2,697,000.

The annual yield from the estate, counting forty pencas to each of the 9,900,000 plants, will be 396,000,000 leaves. These, with one hundred pounds to every thousand leaves, will give us 39,600,000 pounds of sisal fibre. This, sold at eight cents per pound f.o.b. at a Cuban port (sisal is to-day worth nine and one-half cents in New York) will represent \$3,168,000. Estimating the cost of decorticating or removal of the fibre at \$2.50 per thousand leaves, we have an expense of \$990,000, leaving a net return or profit of \$2,178,000.

Utilizing the \$178,000 for cost of additional planting we still have \$2,000,000 clear, which will represent 74 per cent. on the original investment of, say, \$2,700,000. Again, deducting 24 per cent. for interest at 6 per cent. during the four years of waiting for plants to reach maturity, we still have a 50 per cent. dividend. And since in succeeding years from period of maturity, the cost of suckers, preparation and planting, &c., amounting to \$2,000,000, is eliminated, the returns from the said henequen

plantation may be considered as "clear velvet," or practically 100 per cent. ⁴[on capital invested each year.

The above estimates are not guesses; they are based on figures determined from results achieved at the Spanish American Cordage Company now operating at Nuevitas, Cuba, where verification is invited. They can be repeated under intelligent management on any suitable henequen soils in Cuba, and undoubtedly will be as soon as the facts are become known.

We are informed that Governor Fuller, of Massachusetts, and Mr. James M. Curley, Mayor of Boston, both of whom are said to be favourably impressed with Cuba and her opportunities for investment, were invited to visit Havana in 1925, in order to make a tour of inspection throughout the length of the island, so that they could report to their people in New England in regard to the wealth of natural resources which await development in this "Pearl of the Antilles."

The advantages of the sisal industry, therefore, are many, especially at times like the present, when trouble, financially, may arise owing to the breakdown in sugar values, a break that has again come, but has it yet reached finality? These advantages can be summarized as under.

ADVANTAGES OF SISAL AS AN INDUSTRY.

- (1) Comparatively cheap lands produce henequen.
- (2) The plant lives from twelve to twenty years and reproduces itself during life in the form of suckers a hundred times or more.
- (3) It cannot burn as does cane, and animals will not eat it, hence fences are not necessary.
- (4) Its cultivation is easy, and defibering machines are not expensive.

(5) The crop may be gathered, defibered and stored for a long time without deterioration, as a rule.

(6) The demand for sisal is constant throughout the year.

(7) Sisal is seldom, if ever, subject to speculation in the open market.

In view of the above results, actually obtained at Nuevitas, and the great area of land so well adapted to henequen culture in Cuba used to-day only for pasture, there is undoubtedly a great field for the production of sisal and the development of a new agricultural industry ; one which, within the next decade, should not only run King Sugar a close race for supremacy, but will give us another strong line of defence on which to fall back in case of emergency, while adding greatly to the wealth and prosperity of the Republic.

CHAPTER XII

ALCOHOL FROM SISAL REFUSE

NOWADAYS when quite a number of proposals are afloat for turning sisal or abaca (and also banana stem) waste to profit instead of allowing it to become a nuisance and a source of expense, the following article, published in *Der Pflanzer* towards the end of 1910, was translated for me by Mr. F. A. G. Pape and published in *Tropical Life* for April and May, 1912. It has been included here so that more recent statements can be compared with what was then considered to be possible on the subject. Unfortunately I do not remember, if I ever knew, the name of the author of this report.

To my mind, provided the quantity at hand is large enough to pay one to do so, that is to say evenly large enough over a fixed period if not always, alcohol for use as fuel should be "turned out" at a profit, even if only for use in the factory itself. Without any experimental work to go by, one can only prophesy that in the near future sisal estates will run large, i.e., with large central factories, fed either by the owner or owners or, perhaps better still, by small proprietors, renting or owning the land around, who would send in supplies to the factories as is done with sugar-beet or sugar-cane, and the leaves will be received and paid for according to the market value of the fibre.

Supposing such things were already in being, can one look for the following utilization of the whole of the leaf and the absence of any noxious waste giving

trouble and causing expense that should not exist:—

- (1) The cut leaves arrive at the factory.
- (2) The fibre is removed.
- (3) The residue, i.e., 95 per cent. of the leaf, is divided as to solids and liquid.
- (4) Perhaps the waste fibre can be separated from the pulp refuse, and turned into cellulose for paper-making, artificial silk, &c.
- (5) The pulp refuse can be treated and turned into a fertilizer or manure for keeping and use without annoyance or, some claim, when quite fresh can be used as a cattle food.
- (6) The liquid part can be used as a source of industrial alcohol, and possibly, one day, of acids.

Nothing need be wasted, nothing left to become an expense and a nuisance. Here are ideal conditions, so set the list up in front of you to see how near it will pay you to approach to them, or even to surpass them, as by extracting oxalic acid, wax, &c., which have been mentioned as obtainable from sisal if not from abaca or banana waste. In some cases at first, you may not consider the bother and expense of supervision during the experimental stages to be worth risking, but before turning down finally these modern ideas for utilizing, and especially for ridding your estate of the nuisance of sisal waste, give the suggestions a fair trial or evolve better ideas as you go along.

This article deals with the utilization of the *Agave rigida*, var. *sisalana*, of Yucatan. Other agave plants, however, also lend themselves to the manufacture of alcohol, and certain of them yield even greater quantities of alcohol than the sisal agave, having regard to the weight of the leaf. The weight of the leaves, and correspondingly also, of the refuse, varies according to the time of year. In the dry season the average weight of a leaf is from 400 to 420 grm., in

the rainy season from 700 to 725 grm. The weight of the fibre, which amounts to from 26 to 30 kg. per 1,000 leaves, varies less. Consequently, the refuse totals from 92 to 96 per cent. of the leaf-weight, according to the time of year. It consists of a pulp which contains more or less fibre, according to the good or indifferent working of the machine for separating the fibre. Up to now the refuse has been carted some 100 metres away, less only a small portion which was consumed by cattle, the remainder being left to rot. It does not make a very good fodder, yet in Yucatan thousands of cattle have no other, and although they may not become fat on it, they at least exist. The small amount of food value present in the refuse is due to a certain alloy of saccharine matter and other soluble carbohydrates.

The sugar contained in the agave leaves has long been known, and also that the manufacture of alcoholic drink from certain species has been carried on in Mexico for long years past, the well-known drinks, *pulque*, *tequila*, being obtained thereby. In 1908 the author of this report was commissioned by the Mexican Government to make practical experiments regarding the possibility of obtaining alcohol from the refuse of sisal agaves in Yucatan. He was able to demonstrate without difficulty that the quantity of sugar contained in the refuse justified its being regarded as having commercial value.

Analyses were made at different times of the year : on May 5, after six months of drought ; on July 21, twenty days after the beginning of the rainy season ; and on August 28 in the middle of the rainy season ; and the following are the average statistics :—

		May 5	July 21	Aug. 28
Water and other liquids	...	79·0	85·1	86·1
Solid refuse		20·9	14·9	13·9

The solid refuse contains:—

Minerals	...	6.5	7.18	7.05
Nitrogenous substances...	...	3.3	1.60	2.49
Soluble glucose	...	3.8	3.63	14.40
Insoluble glucose	...	22.8	15.45	28.72

Other soluble carbohydrates:—

Cellulose, vasculose, lignose ...	...	25.9	28.77	20.77
&c., &c.	...	73.7	42.37	26.57

These figures differ very little from previous publications, which, however, in contrast to the above, refer to leaves cut some considerable time before and experimented upon in Europe, and d'Herelle demonstrated that important changes take place in the leaves in a few days. The quantity of soluble sugar material increases gradually and reaches its maximum on the sixth day, then decomposition of the sugar formed first takes place; at the same time there is no change in the appearance of the leaves if they are kept in the shade.

The sap obtained by pressing the leaves varies in composition according to the season. The maximum density observed (May 20) was 1104, with 14.6 per cent. hydrolyse in the whole soluble material. These figures show for 1,000 medium leaves in the first case, 36½ kg. of sugar (22 litres of absolute alcohol), in the second case 21.6 kg. sugar (13 litres of alcohol).

The fermentation of the given quantity of sugar caused special difficulties. The attempt to induce fermentation by means of a culture of sugar-cane yeast was unsuccessful, and the author had previously tried in vain with different kinds of yeasts from the Pasteur Institution, but the juice of the sisal refuse could not be made to ferment. There was a twofold reason for this: firstly, the large proportion of organic acids (oxalic), and, secondly, the presence of substances acting as antiseptics to yeasts.

After repeated trials, a natural and thoroughly satisfactory yeast was cultivated which induced easy fermentation where unsuitable yeasts had no effect.

The gain in alcohol thus obtained amounted to 96 per cent. of the theoretical statistical gain, as the following examples show:—

On May 19 a sap with 12.7 per cent. soluble sugar yielded a must containing 7.8 per cent. alcohol.

On May 21 a sap with 14.1 per cent. soluble sugar yielded a must with 8.4 per cent. alcohol.

On August 6 a sap with 9.4 per cent. soluble sugar yielded a must with 3.8 per cent. alcohol.

Based on these laboratory tests the Mexican Government caused a press to be bought and apparatus installed to carry out further experiments with greater quantities. The apparatus for distilling, however, was old-fashioned and much repaired, and was inadequate. Three experiments were made with almost similar results. That made on December 11, one and a half months after the end of the rainy season, was as follows: 500 leaves from 20-year-old trees, and 500 from 8-year-old trees, used for the experiment, showed:—

Weight of leaves	...	...	...	...	611	kg.
Fibre obtained by separating machine	...	...	...	...	32	"
Fibre left in refuse	...	...	...	...	3.5	"
Refuse	...	...	...	...	546	"

The refuse when pressed by a hand-mill yielded 432.1 litres sap with specific gravity 1040. The cakes weighed 96 kg., and contained 52 per cent. moisture, betokening a loss of 60 litres of sap.

The juice was mixed with one weight per thousand of sulphuric acid, and sterilized for twenty minutes at 120° C. Thereafter, fermentation was induced by a culture of pure sisal yeast, a process lasting for forty-eight hours. Result, 17 litres alcohol.

The Minister of Agriculture in Mexico, Señor Molino, owner of the most important agave plantations in Yucatan, commissioned the author to erect and fit

up a factory for dealing with the refuse resulting from defibring 175,000 leaves per day. The first trial was concerned with extraction, for which either of two methods can be employed:—

(1) Maceration or diffusion.

(2) Pressure by means of presses or mills.

At first, diffusion or maceration seemed the most suitable method, but owing to the appearance and uneven nature of the material, the adaptability of this method seemed doubtful. A trial by the pressure process, with due regard to the expense of the apparatus, with a battery of eight casks containing 500 litres each, was made, but the results were very poor, for the following reasons:—

(1) The residue, owing to its uneven consistency, was not exhausted, channels of water were left here and there. Repeated trials gave almost the same results. If the refuse left in the casks after the necessary maceration had taken place was pressed, one could still obtain a juice of 1014 to 1020 specific gravity, with 3 to 5 per cent. sugar.

(2) At every trial the liquid ceased to pass with ease either through one or other of the casks, and the whole process of extraction was interrupted. This happened because small particles, even those only 2 cm. in size, could pass through, and because when such layers were formed in the cask the liquid could no longer pass through. This happened on an average in every fifth cask.

(3) The circulation is an extremely slow process. Often experiments began at 6 o'clock in the morning with only one being successful (at 6 o'clock in the evening) in bringing the sap into the sixth cask. By all other attempts the work had to be interrupted without it being possible to get juice out of the sixth cask.

A minimum of two hours is required for the liquid

to pass through a single cask, and as the sisal juice is very volatile, a considerable loss of sugar ensues.

The author emphasizes the impossibility of macerating the refuse at will ; it would therefore only lead to useless expense and certain failure for any one to try and get alcohol from sisal juice. He has tried all methods, with ascending and descending currents, with cold and hot water, with and without heating of the casks by means of steam pipes, all without success ; and the remarks that apply to maceration apply equally to the method of diffusion.

There remained only the pressing process. Here, on account of the quantity of material, several presses would be required to work at the same time, and this would increase the expense.

The crushing mill is more suitable ; d'Herelle uses a mill similar to those used for crushing sugar-cane. To extract the juice from 100,000 leaves per day, one must use cylinders of about 1 metre, with dimensions corresponding to the material to be used. At first bronze cylinders were used ; then it was found that iron cylinders would do if they were carefully cleaned every day at the end of work, as the juice acts quickly on the iron under the influence of the air. A double mill should be installed, and the residue, moistened with water to form 16 to 20 per cent. of the total juice, according to the season of the year, placed between two cylinders. Experience alone can show the proper amount of water to use.

At first the filtration of the juice caused grave difficulties. The finer particles of the refuse pass through with the juice, and make, even in quite thin layers, an impenetrable substance. In consequence, the filters with metal strainers very quickly get stopped up. To avoid this the following method was employed : At the end of the second press the juice was run on to a continuous metal strainer, 60 cm. broad,

that served as a conduit ; by the juice flowing through this cloth the solid material is thrown out. This brings the residue from the first to the second press. The continuous metal straining cloth is set in motion by means of a cog-wheel at the end of cylinder and a transfer chain, but still the first filtration is not sufficient.

Particles still go through, which later block up the pipes of the distilling apparatus. Centrifugal force is then used. After the first filtration the juice comes into a small centrifugal, with a diameter of 65 to 75 cm., running 600 revolutions per minute, such as is used in a sugar factory ; this is quite sufficient to deal with the refuse of 150,000 leaves per day.

The residue leaves the press with a moisture of 40 per cent, ; it can either be dried and burned under the usual steam kettles, or with special kettles, as is done with sugar-cane, burned without drying.¹ One counts on 5,000 kg. burning material out of 100,000 leaves, and this with the new steam machines should be sufficient to carry on the entire defibrating and distilling apparatus. Sisal refuse is much easier to press than sugar-cane. A 30 h.p. engine is sufficient to drive the two cylinder presses.

The filtered juice is put into a cement tank of 1 c.m. content, with paraffined sides to resist the action of the acid on the cement. Two of these tanks must always be in use, the one filling while the other empties. In these tanks the juice is mixed with the required amount of sulphuric acid (1 per 1,000 of weight) and then sterilized. There is no purpose served in letting the sisal juice ferment without completely sterilizing it first. The presence of albumins, resins, organic acids, and various soluble carbo-

¹ Or can be treated and used as manure.—H.H.S.

hydrates would counteract the action of the yeast, and so suppress the alcoholic fermentation that no alcohol would result.

There are various apparatus for sterilizing. In choosing them, one must be careful that the sap, heated to $100^{\circ}\text{C}.$, eliminates the albuminoids. An apparatus with narrow pipes, or one that is difficult to clean, should be avoided. The author considers as particularly useful a vessel such as is used in distilleries for corn, in which the juice enters by a hole about 50 cm. below the cover, and passes out below into a collecting vessel, cylindrical in shape, made of copper, and with a spiral pipe inside. The hot juice flows into the cylinder from the "steamer," and the cold juice is driven back into the boiler through the spiral pipe. The boiler for the juice from 100,000 leaves must be capable of containing 3,000 litres, the collecting vessel must have a height of 1.50 m. and a diameter of 65 cm. The pipes leading to and from the boiler must have cocks and indexes to regulate the flow. The juice comes from the collecting vessel into another cylindrical vessel containing 600 litres, having at the bottom a spiral pipe through which cold water flows, and which serves as a preliminary cooler. The usual open vessels are to be avoided at this point, as infection can only too easily enter the juice. If wished, the collecting vessel and the cooler can be replaced by a single apparatus after the style of the cooler in the "Kill" system.

The author used a Lawrence cooler, with thirty pipes 2.80 m. long for the material from 1,000 leaves, that is, when the temperature of the water was $24^{\circ}\text{C}.$ If the water is only $18^{\circ}\text{C}.$ the cooler is sufficient for 150,000 leaves.

The cooled juice is now fermented. This is the most difficult point in the whole process, as the fermenting is a very delicate work, and can only be

successfully done by a chemist with a thorough knowledge of the chemistry of fermentation, and capable of cultivating special kinds of yeast; the sisal juice can only be fermented by sisal yeast. The apparatus necessary is as follows: (1) An apparatus for the culture of yeast with a capacity of 350 litres; (2) two vessels of zinc, with a capacity of 6,000 litres each; (3) twelve wooden fermenting vessels with a capacity of 18,000 litres each. This is sufficient for the preparation of the juice from 150,000 leaves in ten hours. In fourteen hours 200,000 leaves can be dealt with. The Barbet apparatus yields 2,800 litres of alcohol in twelve hours. The sisal alcohol is of the very finest quality, and fitted for consumption.

At the time of writing the apparatus had only been a few days in use, and obtained a result of 13½ litres alcohol from 1,000 leaves, but it was hoped by means of improvements in the fermentation to increase this to 16 litres, as previous trials with closed, and therefore aseptic, fermenting apparatus, yielded 17 litres. In this case the fermentation process was carried on in open vessels, and this has a great influence on the sisal juice, owing to its tendency to change.

It is reported in the *Pflanzer* of 1910 (?), Nos. 14 and 15, that three more similar distilleries have been erected. But even with a result of 16 litres, the author considers the manufacture of alcohol out of sisal refuse as very profitable, since the material costs nothing. An apparatus dealing daily with the sap of 150,000 leaves, if made of the best material, would cost 300,000 francs. The staff must consist of a chemist and biologist, a director, a European as works manager and distiller, with eight workmen.

In addition to the refuse from the defibrating machine, the stalks from the plants that had been denuded of their leaves, and so rendered useless,

contain a reserve substance in the form of carbohydrates easily convertible into sugar. A steam plant, such as is used in the alcohol factory, with wide pipes (10 cm. in diameter), would be necessary. The stalks, cut or broken up by machinery, are put in the boiler with a double weight of water containing 1 per cent. of sulphuric acid, and boiled for an hour and at half a at a pressure of 1 kg. The juice is then separated from the residue by means of a centrifugal machine, and added to the sap from the refuse for further treatment. If one wishes to treat the two juices separately, that from the stalks must be diluted with water before it is sterilized, in order to bring it back to the desired specific gravity of 1060. Each plant yields about $1\frac{1}{4}$ litres of alcohol. In Yucatan, a plantation yielding 150,000 leaves daily will yield 175,000 stalks yearly. In East Africa, where the plants live for a much shorter time, the number of stalks available is correspondingly larger.

According to this the yearly production of alcohol from a sisal plantation yielding 150,000 leaves daily for two hundred and fifty days would amount to 7,405 hl. [hectolitres].

The author touches briefly on the value of the refuse for the manufacture of paper, and comes to the conclusion that though an excellent product will result, it would not be profitable, as the dry refuse contains only 30 per cent. cellulose, and therefore requires too much soda for the hydrolization of the foreign ingredient, and also too much chlorate of lime for bleaching. He makes a comparison with other valueless waste materials in Europe, which even there, where the necessary chemicals are only half the price, cannot be turned into paper at a profit.

The refuse finally remaining, diluted with water and mixed with chalk as a neutralizing agent, can be used for manure. A litre of such refuse contains on

an average 2.3 grm. nitrogenous substances and 6.7 grm. mineral material, containing 2.74 chalk, 0.41 grm. phosphoric acid, 0.53 potash, so that from this refuse one obtains yearly, using 100,000 leaves per day: 22,800 kg. nitrogenous substances, 27,400 kg. chalk, 5,300 kg. potash, and 4,100 kg. phosphoric acid.

In conclusion, the author warns his readers against over-haste, but urges them at the same time to follow the example of the planters in East Africa, and institute sisal plantations because, if to the value of the fibre obtained be added the value of the refuse for the manufacture of alcohol, he considers a most profitable undertaking would result.

* * * * *

Discussing how sisal fibre can be produced at the least cost to the planters, it soon became apparent that one of the first things to be considered is as to whether the 85 or nearly 90 per cent. of moisture in the leaves, plus the added water, can be utilized, since it has been described as very fermentable, to distil alcohol from, and even to extract acids, from the liquor that is left, instead of as at present having to spend vast sums in disposing of the refuse, and spoiling good water (into which it is sluiced) when doing so.

To arrive at any conclusion in the matter, it has to be decided whether, whatever may be said of sisal refuse as a troublesome fermenting mass, it is altogether suitable, with its added water, for the production (1) of industrial alcohol and (2) of acetic and other acids from the very acid liquor remaining in large quantities. If this can be done, would it pay to do it, not so much perhaps for profit in the usual way, as to reduce the cost of and nuisance from the refuse in disposing of it according to present methods.

Since about 90 per cent. of the sisal leaf is represented as moisture, according to the analyses, a ton of these leaves, with an average weight of $2\frac{1}{2}$ lb. each, would have about 2,000 lb. of water, and three or four times that quantity of added water to wash the mucilage, &c., from off the fibre as it is being decorticated in the machine. As the makers of these decorticators talk blithely of 150,000 to 200,000 leaves going through a machine in a day, it is easy to realize what an enormous amount of fluid has to be dealt with, and if it is the nuisance that we are told is the case, surely it would pay to deal with it in order to :—

(1) Detach the water itself from the waste fibre and mucilage, and, roughly filtering it, use it again with advantage, especially in places like East Africa, where water tends to be scarce during certain periods of the year. Here I suppose you would have to run everything as it comes from the machine into large tanks, and drawing off the liquor, leave the sludge at the bottom.

(2) Isolate the broken fibres which are of value as sisal waste, to be shipped together with the tow and perfect fibre.

(3) The residue, including the sugars, &c., which cause fermentation with such a quantity of water as is necessary, could then be used as the raw material for power alcohol and acid-extraction.

(4) The remaining sludge could now be put back on the land where it will replace many of the valuable plant foods that would otherwise be lost. For instance, we are told that there is 176 lb. of potash to each ton of leaves, or something of the sort.

If this sequence of operations could be carried out, one feels that the refuse which is now an expense and a nuisance would show a profit, or at least reduce the cost of production, but its ability to do so depends upon whether, according to Mr. McGregor, the mass is

easily fermentable. Have any of the readers of this book any experience in or information on the matter?

The idea generally is worth considering, because all of these fibres have the same large proportion of fermentable refuse and much water. Sisal is an *Agave*, manila hemp is a *Musa*, and so is the banana tribe, and to-day the United Fruit Co. of America and other producers of bananas on a large or small scale, lose hundreds of thousands of pounds sterling through what is generally known as Panama disease, i.e., a *fusarium* or wilt disease. This checks the circulation of the sap up the plant and so causes it to wilt because it does not receive its proper amount of moisture. When this bacteria pest gets hold of the ground, which it does in about five or six years time, then that area has to be abandoned and fresh land sought out. Think of the terrible loss that this means. Yet surely if they did not cut down their banana stems and leave them rotting on the ground, a mass of fermenting matter (see p. 211), they would not be troubled with Panama disease, at any rate not to the extent we are told is the case to-day. Why not therefore take the banana stems, expel the moisture or else chop up the whole stem (weighing anything up to 120 or 140 lb. and planted quite close together on the estate, so that it is easy to imagine the tonnage) and then use that as your raw material to distil from.

Whilst my book deals with sisal production and the utilization of the refuse, it is as well to bring this in to stimulate attention to the matter, and to encourage research by competent experts in order to see whether that which costs so much to-day cannot be turned to good account to-morrow. If any of the readers of this book care to follow up the matter, I shall be glad to hear from them and to put them into touch with other research students. The big distillers of industrial alcohol, or producers of acetic and other

acids, may not at the moment be disposed to go into the matter (as a matter of fact they are not) as they do not feel justified in tackling what must be a very considerable problem at the moment, particularly as there are a number of raw materials available which are more easily amenable to treatment. This however does not say that it would not pay the large estate owners in the tropics to carry out experiments with the idea of utilizing the alcohol and acid themselves, or of selling it to others, and at the same time of reducing the cost of production generally. The whole matter may seem rather in the clouds at present to the experienced scientist; also it may not have been properly discussed and described; all the same it deserves attention and, with the help of Mr. MacGregor (of Messrs. George Scott (London) Ltd.), I mean to carry on my investigations until I can lay the results in a convincing manner before the sisal and chemical world to carry it to finality.

CHAPTER XIII

COLOMBIAN PITA FIBRE

By M. T. DAWE, C.B.E., F.L.S.

THE pita fibre of Colombia and other adjacent South and Central American Republics, although of considerable importance in the localities where it grows, is practically unknown to the world of commerce, except for a casual parcel sent to fibre merchants and manufacturers by travellers who, having come across the plant in their wanderings and impressed by the high qualities of the fibre, have collected and forwarded samples. Pita, it may be mentioned, is a very elastic term in Central and South American countries, as it may be used to denote sisal hemp and other fibre plants, as well as cord or string. The Colombian pita plant is, however, not in any way related to the sisal hemp plant, it being a species of *Ananas*—a kind of wild pineapple. It has hitherto been thought that this was *Ananas macrodontes* Morren, but recent examination at the Royal Botanic Gardens, Kew, of material collected by the writer in Colombia, proves the Colombian plant to be quite distinct from this species. Steps have been taken to procure further botanical material of the plant, and

¹ This section—divided in two parts—appeared in *Tropical Life* for December, 1920, and January, 1921, and is reproduced here at the request of many who ordered copies of the original or the reprints when the Arghan boom was on. As our supply of those issues was exhausted almost immediately a large number of interested people have never seen the article.

when this has been received it is hoped that its botanical identity will be definitely established.

DESCRIPTION OF THE PLANT.

The pita plant very much resembles the pineapple ; in fact, it might be very appropriately described as a giant pineapple plant. A single mature plant carries from twenty to forty leaves, which attain a length of 10 ft. or more, and are about 4 in. broad in the centre. They are convolute towards the base, otherwise flat and tapering towards the apex. The margins are toothed, and from the middle to the base the teeth turn downwards, and in the upper half upwards. The flowers are produced in pineapple-like heads, which are borne singly, or more usually in groups of two or three, and are about 9 in. long and $4\frac{1}{2}$ in. broad ; these differ from the ordinary pineapple fruits in having conspicuous rose-coloured bracts whilst the flowers are blue and fugitive.

Fruiting is irregular, and the seed is not commonly the means of propagation. The plant throws out stolons underground and young plants or suckers come up all around it. So strong is its reproduction by this method, and the growth of the plant so vigorous, that it takes entire possession of the land to the exclusion of other forms of undergrowth vegetation, excepting trees and palms, which afford the shade necessary for its growth. It therefore forms impenetrable masses which cover extensive areas ; these so much resemble plantations that the Colombians call them " pitales."

OCCURRENCE OF "PITALES."

Pita is a shade-loving plant, and is usually found in the shade of the tropical forests as undergrowth. The type of forest in which the plant occurs can be

seen in photographs of the Chiriguana forest, famed throughout Colombia for its extensive "pitaes." An interior view of this forest indicates the density in which the pita plant grows to the exclusion of other vegetation, entirely covering the land league after league. It is impossible to penetrate these forests except by hacking a way through by a machete or cutlass. The plant flourishes in light sandy soil, but will not grow in wet land or on land subject to frequent inundation. Pita lands are therefore generally healthy, and the forests are usually well watered by clear flowing streams from the Cordilleras. It is generally believed that the pita plant will not grow in the open exposed to the sun; this is, however, erroneous, as the writer has seen the plant growing luxuriantly in various parts of Colombia in open land. It may be true that the plant will not thrive in the open in the tropical regions, as where the plant has been observed in the open it has, in every case, been in the subtropical parts of the country. Illustrations of pita growing in open land as a hedge plant in the Department of Caldas are in my possession, and go to show that it does not grow any less vigorously there than it does in the shade of the tropical forests.

The plant is found in different parts of Colombia, from practically sea-level to nearly 3,000 ft. above. It is, however, more usually found in patches, and not generally covering large areas as at Chiriguana, except in a few other localities, such as the Carare, Atrato, &c. From the manner in which one finds the plant growing in the interior of Colombia in clumps or patches, it is not improbable that it was at one time cultivated or conserved by the indigenous Indians, who from time immemorial have prized the fibre which it affords for its great strength and durability.

NATIVE METHOD OF EXTRACTING THE FIBRE.

The native extracts the fibre by placing a single leaf on a flattened log of wood, and holding one end of the leaf with his foot ; by means of a long stick with a flattened end he scutches away the waste material of the leaf till only the clean fibre remains. This is, of course, a wasteful method of extracting the fibre, as it is only partially recovered by this means. It is, further, a slow process and impracticable from a commercial point of view.

ITS USES.

The pita fibre is valued by the Colombians as being the strongest and most durable of its class, and is employed by them for all purposes where strength and durability are required. The Caesar river, in the watershed of which Chiriguana lies, together with its extensive lakes and lagoons, forms an important fishing region, and large quantities of pita fibre are employed in this locality in the manufacture of fishing nets.

It is also used waxed by local shoemakers, instead of thread, for sewing boots, &c. In Mexico the fibre was formerly used for strings of musical instruments, for fancy needlework, and waxed for saddlery and leather work.

Commercially, it would be classed as a hard fibre, and would enter into competition chiefly with henequen or sisal hemp for ropes and for use as binder twine in harvesting, though it is finer, stronger and superior to the fibres mentioned, and really too good to be employed for binder twine.

Experiments have been made with a view to its use, mercerized, as a substitute for silk and for the manufacture of cloth, with promising results. For such applications it would, of course, realize much

higher prices than if used in competition with sisal hemp.

COMMERCIAL VALUATION OF THE FIBRE.

A sample of the hand-prepared fibre from the Chiriguana "pitaes" was forwarded by the writer in 1918 to the Imperial Institute, London, for examination, and the following is the result of their chemical examination and the report received:—

	Per cent.
Moisture	9.8
Expressed on the dry fibre	
Ash	0.6
a-hydrolysis, loss... ..	12.6
b-hydrolysis, loss... ..	16.8
Acid purification, loss	2.7
Loss on washing in water	2.8
Cellulose	74.7

Length of ultimate fibres: from 1.7 to 6.1 mm.; mostly from 3.0 to 4.2 mm. (mm. = 0.393 inch).

"The sample consisted of clean, well-prepared, soft, lustrous fibre of pale straw tint. The fibre possessed good strength and varied from $8\frac{1}{2}$ ft. to $10\frac{1}{2}$ ft. in length."

Commercial experts who reported on the value of this fibre for the Imperial Institute stated that it was somewhat similar to sisal hemp obtained from *Agave cantala* in the Philippines and the Dutch East Indies, and that the strands were fairly fine, of good strength, and thoroughly well decorticated. They considered that this fibre could be used as a substitute for sisal hemp, Manila hemp, or other hard fibres, and they valued it at the current Government maximum price for such fibres, i.e., £99 to £100 per ton¹ (May, 1918), adding that the pre-war value would have been from £28 to £30 per ton.

¹ Please note this value for sisal hemp. No wonder men in khaki went "sisal mad" for a time.—H. H. S.

In January, 1917, a sample of the fibre was submitted to the fibre expert of the United States Department of Agriculture, whose report ran as under:—

“The fibre is of excellent quality and doubtless there would be no difficulty in finding a ready market for it in this country at the present time at a price equal to that of henequen of Yucatan, which was quoted (early in 1917) at $16\frac{5}{8}$ cents per lb. in New York. It seems very doubtful whether American manufacturers would pay for the fibre in quantity as much as the retail prices for small lots sold in Colombia. If it can be produced in quantity, however, there would be a ready market for it in this country in lots of many tons.”

Further samples have been submitted to merchants and manufacturers, and offers to take the pita fibre in quantities of 1,000 tons have been received. A large consumer, recognizing the excellent qualities of the fibre, has offered to take the whole output of the “pitales” of Chiriguana for the period of three years, giving the current market price for sisal for it. An important fibre broker judged it “the finest fibre possible.”

There is, therefore, no doubt as to the commercial value of pita fibre, or that there exists a ready market for it at prices equal to the best sisal or henequen. In face of all this, when the fibre is better known one feels that it will command better prices than these fibres, because of its fineness, strength and durability.

A few years ago this fibre fetched at Chiriguana 15 to 20 cents per lb., and at the Magdalena river ports 25 to 30 cents per lb.; at these ports later, however, it fetched from 40 to 50 cents per lb. This is due largely to the fact that owners of pita lands forbid the collection of the fibre, owing to the destruction and waste incurred by the old method, to avoid which they

were awaiting machinery for its extraction on a commercial scale. It is also due to some extent to a slight increase in local wages.

STOCKING OF THE "PITALES."

A surveyor, who has made a careful survey of the Chiriguana forests, estimates that the "pitaless" contain from 5,000 to 8,000 plants per acre, and even more in the richer parts. Sisal or henequen is planted in East Africa at from 900 to 1,000 plants per acre, in certain other countries as many as 2,000 plants are put to the acre; it will therefore be seen that the natural stocking of these "pitaless" is very much higher than the usual stocking per acre of sisal plantations.

PROBABLE PRODUCTION OF FIBRE.

It is estimated that the pita plant will afford thirty leaves per year in two cuttings (in Mexico the henequen plant yields twenty-five leaves per plant per annum). If we take, to be conservative, the minimum stocking above referred to viz., 5,000 plants per acre, there would be an annual production of 150,000 leaves per acre. Now one hundred leaves weigh from 66 to 70 lb., according to two independent experiments, so taking the mean of the two computations, viz., 68 lb., the 150,000 leaves should weigh 102,000 lb.

It has been found that by the native hand method of extraction every one hundred leaves, or, say, 68 lb., yield 2 lb. of dry fibre. It is calculated, however, that there is a loss approximating to nearly 40 per cent. of the actual fibre content of the leaf, which would therefore be about 5 per cent. Allowing, however, for the recovery of only 3 per cent. by mechanical extraction, it will be seen that the return per acre should be 3,060 lb., or, say, about $1\frac{1}{4}$ tons of dry fibre.

THE FUTURE OF PITA.

One can claim that, even on conservative estimates, those pita fields are capable of giving a yield comparing favourably with that of the best sisal plantations. The advantages of exploiting natural "pitaes" as compared with plantations are obvious. In the former case all that is necessary to commence production is to instal machinery. There is no long and tedious wait while land is being cleared and planted and weeded, as in the case of sisal planting, which involves a wait of about three years before the plants come into bearing, and then replanting at every few years' interval. There is no locking up of capital for a long period, which is to-day such an anxious matter in the case of plantation enterprises, owing to the uncertainty of markets and instability of exchanges. On the contrary, there should be immediate production and immediate returns once suitable machinery has been installed.

The difficulty hitherto experienced has been the fact that no suitable machinery has so far materialized which successfully extracts the fibre from the leaf of the pita plant. Since the writer discovered the pita fields of Chiriguana in January, 1918, very considerable strides have, however, been effected in this direction. One machine has been devised in New York at the suggestion of the writer, and is at present being patented in the United States; it is hoped that this machine will solve all the difficulties which have confronted the commercial utilization of the pita fibre to this day. Another and distinct type of machine is at present being tried out in the pita fields of Central America, and the adaptation of existing fibre machines in this country and the Colonies is in view which promise to give more or less satisfactory results.

Apart from mechanical extraction, the possibility

of extracting this fibre by "retting," either by microbiological action or by chemical means, or by a combination of the two, is not being lost sight of. It is therefore probable that before long sisal and other similar hard fibres will have in pita a close competitor.

The exploitation of these natural pita fields would therefore appear to deserve the most serious consideration of financial people interested in the development of this type of fibre, and in the all-important question of the future supply of a valuable commodity.

* * *

The above has not been included to cause sisal men to go "pita-mad," but to enable them to realize that there is at least one other fibre useful enough to compete against sisal, whether it does so during this century or not. Whilst writing the above comes another letter from Cyprus in which Mr. Dawe says: "Re 'pita,' this word is used loosely in South America and really means 'string.' The name 'pita' is not applicable to Mauritius hemp, which is the 'fique' in Colombia."—H. H. S.

CHAPTER XIV

WANTED—A SISAL PLANTERS'
ASSOCIATION

With "Tropical Life" as its Organ

THE following appeared in *Tropical Life* for December, 1925, and as it attracted considerable attention at the time, it may be an advantage to the producing side of the industry to reprint it here.

Are you a sisal man? i.e., a planter, baler, exporter, buyer or spinner; if so, do you agree that a Sisal Planters' Association is needed, with equal headquarters in New York and London, and branches elsewhere as agreed, and that, if formed, such an Association would benefit the industry generally and yourself in particular to a considerable degree? If you consider that such an Association is needed, please let us know your views as to how it can best be formed and so help us get started fairly quickly. We have written our good friend and contemporary *The Cord Age*, of America (20, West 34th Street, New York City), discussing the idea with a view to their doing for America what we shall be pleased to do for the British Empire from London, given the necessary support. Their answer has just come to hand, and in this they say, "We are always interested in sisal and are glad to see this interest on your part. If we can be of service to you in any way, we hope you will not hesitate to call on us."

Mr. Alfred Wigglesworth, in a letter on the matter, said, "I thank you for your letter of the 15th inst., especially for the friendly offer to make *Tropical Life* an organ for the sisal trade. I shall not fail to

remember this in case there should be any desire to go in for propaganda work in this direction. Sisal, however, is very differently placed to sugar or coffee, articles with an unlimited demand.

"It is a very interesting point you raise regarding the low price of sugar, and its possible bearing on an increase in the production of sisal. At present we have about balanced the supply and demand for sisal, and I hope the consumption will grow with the increase in production, which we look for in the next two or three years, so as to maintain a level price."

"I understand," wrote Lieutenant-Colonel Elkan, D.S.O., O.B.E., Managing Director of the Mazimbwa Sisal Development Syndicate, Ltd., "that it is suggested that a Sisal Planters' Association be formed with equal headquarters in London and New York to enable all those interested in the cultivation of sisal to keep in touch with one another and thereby work for their mutual benefit. I am very much in favour of an association of this kind being formed.

"The cultivation of sisal, though by no means a new industry, is not at present fully appreciated by the public. Cotton, tea, rubber and cocoa, and similar products are household words, because the public come daily in touch with them, but sisal, which is almost equally as necessary to life, is hardly known, and I do not suppose one person in a thousand has ever heard of it.

"If it were generally known that corn cannot be economically harvested without the use of binder twine, which is universally made from sisal, and that this product can also be used in many different ways to supplement or even replace hemp, it would be realized what a very valuable article it is.

"At present (in 1925) the world's demand is above the supply, and planters would do well to get in touch not only with one another to discuss the most eco-

nomical methods of production, but also with buyers throughout the world so as to ensure that their produce is sold in the best markets. I therefore hope that your efforts to form a Sisal Planters' Association will meet with success, as this would go a long way to meet the needs I have briefly outlined."

Other letters to hand suggest that "A Sisal (Industry) Association" might be preferable, especially in name, so that there would be no doubt of all sections being included and welcomed. All producers however seem to think well of the idea of having an organ in London.

* * *

Since writing the above we have had letters or telephonic communications with the leading men over here interested in sisal, as a result of which it would seem that, so far as this side is concerned, they would like to wait a little before expressing an opinion. This, however, does not say that the actual producers might not form up together, and in any case that it would do no one any harm to make use of *Tropical Life* as a mouthpiece or organ. We shall be very pleased to act in that capacity, and devote space to fuller market reports, statistics, &c., providing, of course, our list of subscribers grows in proportion. Those in favour please say Aye!

To our own folks we would add, in commenting on the above, favourably or otherwise, "Will you be good enough to say whether, in your opinion, such a body should be established on an international basis to include Yucatan, or whether British interests would, you feel, be better served if the Association was confined to British producers? If this latter, could we, and should we, include those whose planted areas are on non-British soil, so long as their headquarters or office is in London or elsewhere within the Empire, and whose capital is entirely or mainly British?"

CHAPTER XV

MISCELLANEA

EMPIRE-GROWN SISAL—THE EMPIRE MARKETING BOARD'S MEMORANDUM

As *Bulletin E.M.B.* No. 10, the above Board discussed sisal from the point of view of its importance to the manufacturer. Issued in October, 1928, at the moderate cost of sixpence, the information given should at least be up to date. In the text on which the tale is based, we are told that the increasing supplies of sisal now becoming available in East Africa and other parts of the British Empire, justifies the wisdom of calling the attention of those using the fibre as their raw material to this source of supply, especially in view of the demonstrated suitability of the fibre for marine cordage in addition to its other well-known uses.

The tests, made to prove this suitability of sisal for marine cordage, was touched upon in *Tropical Life* for April (1928), p. 9—where it was explained that the Imperial Institute has seen fit to publish in pamphlet form the results of the investigations carried out under the auspices of the Institute's Advisory Committee on Vegetable Fibres to test the value of sisal hemp rope for purposes where it would come more or less into contact with salt water.

According to the report issued, it seems that in view of statements made from time to time there is a general impression that sisal hemp is unable to withstand the action of sea-water. This being so, the Imperial Institute decided as far back as July, 1925,

to undertake an investigation with the object of determining definitely the effect of sea-water on the strength and durability of the fibre in comparison with Manila hemp. In order to obtain material for the tests application was made to Messrs. Wigglesworth and Co., Ltd., for samples of East African sisal and Manila hemp of suitable quality.

Samples of East African sisal of two qualities and a sample of Manila hemp of Grade D¹ were kindly supplied by the firm and submitted to investigation. The results obtained were not concordant owing to the fact that the strands of fibre in a sample vary so greatly in strength ; for example, in experiments with sisal hemp of No. 1 quality, the breaking strain of individual strands varied from 350 grm. to 2,500 grm., and in an experiment with Manila hemp D grade, the breaking strain ranged between 250 grm. and 2,325 grm. This being the case, it would seem that, although a large number of tests were made, the average results cannot be regarded as affording trustworthy data. In view of this it is not considered worth while to record the detailed results in the present report.

When supplying the samples of fibre it was pointed out by Mr. Alfred Wigglesworth that it was of great importance that, if possible, the test should be extended to sisal ropes, as if it could be shown that sisal hemp could be used as a substitute for Manila hemp for rope making it "would mean a great deal of money being kept within the Empire which is now sent out for the purchase of Manila fibre." Mr. Wigglesworth kindly offered to supply the necessary ropes for trial, and discussed the matter with Mr. Hiram Craven, of Messrs. Craven and Speeding Bros., Sunderland. In the course of correspondence Mr.

¹ See p. 212 for list of grades of Manila hemp.

Craven stated that a disadvantage of sisal ropes is that they swell when wetted and will not run easily in the blocks. He added that "for the same reason, viz., that sisal appears to absorb the moisture and swells, the rope also becomes heavy, and for hauling purposes the rope sinks, whereas Manila hemp appears to be very much lighter when in the water, and although I do not claim that it floats on the top, yet it does not readily sink like a stone in the way that sisal rope does when it is wet." Subsequently Messrs. Craven and Speeding Bros. kindly forwarded three pieces of 3 in. rope, each 300 ft. long, marked No. 1, No. 2 and No. 3. No. 1 was made from first quality East African sisal, No. 2 from unbrushed East African sisal and was a superior No. 2 quality. No. 3 was made from J grade Manila hemp.

A scheme of investigation was drawn up which was designed to test the points in which sisal hemp has been alleged to be inferior to Manila hemp, viz.:—

- (1) That its strength deteriorates more rapidly on exposure to sea-water.
- (2) That it swells more when wetted and will not run satisfactorily in the blocks.
- (3) That it sinks more rapidly.

After the ropes had been stored for some months under the same conditions, their length and weight were determined as follows:—

				Length Feet		Weight Lb.
I.	Sisal, 1st Quality, B.E.A.	...	...	295	...	80
II.	Sisal, Unbrushed E.A., Superior No. 2	...	...	293	...	75½
III.	Manila, J. Grade	...	...	294	...	76

The three ropes were 3 in. hawser laid of three strands, thirty yarns to the strand. Measurements of the circumference of the ropes showed that it was rather more than 3 in. but approximately the same in each case.

The results of these trials have indicated (1) that East African sisal hemp of No. 1 quality withstands

the action of sea-water as well as or even better than Manila hemp of the "J" grade, whereas East African sisal hemp of No. 2 quality is slightly inferior in this respect to Manila hemp; (2) that when immersed in water the Manila rope does not increase in girth so much as the sisal ropes, and in this respect Manila hemp is superior to sisal; (3) sisal fibre sinks far more rapidly in water than Manila hemp.

A further series of trials is now being carried out on similar lines, for which sisal planters should be glad, as the whole matter is of the highest importance to sisal growers everywhere. One has become so obsessed with the idea that sisal is good mainly for binder-twine, that the fact of its having hawsers and ropes as well as twine for "its bow" may revolutionize the industry and encourage producers not only to turn out more sisal, but what is most important, to turn out better and better fibre, so as to give their crops every chance of winning, and to continue ahead in this competition with Manila hemp. We noticed that *The Cord Age*, 20, West 34 Street, New York City, calls special attention to these investigations on p. 32 of its issue for February, 1928.

This naturally causes the question to arise, "To what extent, given the will to make the change, can British-grown sisal be expected to take the place of Manila?" During the last four years, 1924-27, the U.K. is down as having imported, and therefore one can take it as having used, an average of 69,734 tons of hard fibres per annum, of which no less than 52,493 tons were Manila hemp, 7,234 tons British East African sisal, 6,737 tons New Zealand hemp, whilst of Mexican henequen we took 420 tons only on an average, with fluctuations from 885 tons in 1924 to 45 tons only in 1925.

Yet on p. 7 of the E.M.B. report we are told that whilst most of the Mexican henequen is exported to

the United States to be made into binder-twine—in 1919 it is estimated that 99 per cent. of Mexico's total output went to America—serious endeavours are now being made to extend the demand for such fibre or fibres, and it is estimated that about 3,000 tons have recently been sold in Great Britain, against, be it remembered, 45 tons only during the whole of 1925 and 47 tons in 1926. Apparently, therefore, there are some who believe that more sisal can be used, and if this is so, why not British-grown?

By the way, when will it be agreed to a nicety, what is the true botanical name of the plant that gives us what we all know as Mexican sisal? When you have thoroughly mastered the contents of this book, you must agree with the writer and many others that each authority seems to "trot out" a new botanical description for the fibre from Mexico. According to the E.M.B. memorandum, "Henequen or Mexican sisal is extracted from the leaves of certain species of agave and mainly from those of *Agave fourcroydes* Lam (*A. rigida* Miller var. *elongata* Jacobi), known locally as sac-ci. How does this compare with the other classifications, especially when at the foot of the same page the story goes on to say: "The only other hard fibre of commercial importance is that known as sisal, which is derived from the leaves of *Agave sisalana* Perr. (*A. rigida* Miller var. *sisalana*), a plant which is a native of Central America and has been introduced into most tropical countries of both hemispheres?"

On the question bulbils *v.* suckers, the E.M.B. tells us that "the sisal plant rarely sets seeds, its propagation, therefore, is effected by other means, viz., bulbils or suckers, the latter being usually preferred." Directions then follow as to how the planting should be done in either case.

Until the writer "met" this report he had always

reckoned that half a ton of fibre went to the acre. Apparently, in East Africa, twice and even three times that quantity can be looked for, of fibre, too, that is well cleaned and so without impurities to add to the weight, for we are told that "In Kenya about seventy leaves are removed at the first cutting, whilst subsequently two cuttings of about twenty-five leaves each are taken annually. Each plant should thus yield about 250 to 300 leaves during its life of seven or eight years. In Mexico the henequen plant yields only about twenty-five leaves a year, but cutting can generally be continued for ten or fifteen years, and occasionally longer.

"The sisal leaves produced in East Africa weigh on the average about 2 lb. each, and yield about 3 per cent. to 4 per cent. of dry fibre, or about 60 to 80 lb. of fibre per 1,000 leaves. In Mexico the henequen leaves weigh less but furnish a larger yield of fibre, usually stated as between 4 and 5 per cent. This is probably due to the fact that the plant in Mexico is grown under arid conditions so that the leaves contain less water than those grown in the moister soil and climate of East Africa. It has been estimated that on the average 1,000 henequen leaves give about 75 lb. of fibre. When it is remembered that the Mexican fibre is not so well cleaned as the East African, but contains a good deal of impurity, it is evident that the yield of fibre per leaf is not much greater in the case of henequen than in that of East African sisal. From the figures given (p. 11 of the Report, where rows planted 8 ft. apart and 6 ft. between the plants, giving 48 square ft. to each plant or about 900 plants to the acre on the Highlands of East Africa compared with 1,300 plants to the acre, i.e., 32 square ft. to each plant, at the Coast) it will be seen that in East Africa the annual yield of fibre should amount to about one to one and a half tons per

acre." How does such a yield compare with the estimates given elsewhere? If the older estimates do not give so much, can one claim that improved methods of cultivation can and have brought out increased yields?

Agave fibres, O. W. Barrett tells you in his book, "The Tropical Crops," p. 335, rank in importance after cotton. Their trade value is around \$35,000,000 (say £7,000,000) or more a year. The principal kinds are, he points out, as follows, and it is good to compare his names with those of other authorities:—

Henequen or Yucatan sisal = *A. fourcroydes*, or *rigida sisalana*.

Sisal = *A. sisalana* or *A. rigida sisalana*.

Mauritius hemp = *Furcraea gigantea*.

Maguey or Philippine sisal = *A. cantula*.

Zapupe = *A. zapupe*.

Ixtle = *A. heteracantha*.

Cajun = *Furcraea cubensis*.

The maguey of the Philippines is of unknown origin, probably a cultigen. The output is now around 27,000 tons and slowly increasing. Mauritius hemp is an American plant; as an exception to the others, it is not satisfied with a soft rock soil instead of earth.

MALAYA.

The Malayan jungles, claims O. W. Barrett in the same book, are full of wild bananas, often in vast pure stands. Some day their fibre, as that of the *Musa textilis*, or Manila hemp, will be utilized, not for cordage but for paper or fabric making. The fibre of the common banana also.

In the Handbook on Malaya, compiled for the British Empire Exhibition at Wembley in 1924-25, out of the 300 pages that went to make up the book 8 pages were given up to sisal, and from those particulars the following are worth noting:—

The world's annual consumption of hard fibres was, in 1924, over 350,000 tons. In 1913, the year before the War, German East Africa exported 20,000 tons of fibre.

Manila hemp (*Musa textilis*), sisal, and Mauritius hemp can all be grown in Malaya and appear promising, but Mauritius hemp is said to be less suitable than sisal, and to give a lower percentage of fibre.

A. cantula is said to stand a higher rainfall, hence its success in Java.

As with others, Malaya discusses bulbils *v.* suckers, and the latter win. Sisal, we are told, is propagated from the small plants known as bulbils that arise in the axils of the flower-stalks, or from suckers from the rhizome; the latter are recommended. In either case they are planted in nurseries, which should be tilled to a depth of about 1 ft., the beds being about 4 ft. wide with 1 ft. paths between. The bulbils or suckers are spaced 9 in. apart in the nursery beds. Shading is unnecessary and watering is seldom required; weeding, however, is important. The plants are generally kept in the nurseries for about one year.

PLANTING AND CULTIVATION.

The most suitable soil is a fairly dry, permeable, sandy loam containing a small amount of lime. Good drainage is essential as the roots of the plants are liable to be damaged by standing water. On poor soils the plants make inferior growth, but are said to contain a larger proportion of fibre than plants grown on rich lands. Hilly land is well suited for sisal cultivation, as it allows of easy drainage. It is not necessary to break up the land, but all the undergrowth must be removed. Holes, 1 ft. deep, are made in rows 8 ft. apart, and 6 ft. apart in the rows, which allows for 900 plants to the acre. Planting should be undertaken during the rainy

season, all fibrous roots and lower leaves having been first removed to facilitate new growth.

Systematic weeding is necessary throughout the period that the crop occupies the land. Light tillage to a depth of 3 or 4 in. is recommended when the clearing is about one year old; subsequent tillage is unnecessary.

HARVESTING (MALAYA).

The period before harvesting varies, but in general cutting commences within three years of planting out, or about four years from the planting of the bulbils in the nursery. The leaves, when ready for cutting, are removed close to the trunk, care being taken not to injure the younger leaves of the plant. The estimated yield under good conditions is from 1,000 to 1,200 lb. of dry fibre per acre; one ton of raw leaves will produce between 60 and 80 lb. of dry fibre, yielding say 3 per cent. to 4 per. cent. of dry fibre. At least 1,000 acres should be planted to warrant the erection of a factory installation of the necessary machinery for the production of first quality fibre. Remember, a constant supply of good water is essential for the factory, also when erecting it that trollies when heavily laden run downhill as easily as the empty wagons can be pushed uphill. Both for water supply and transport purposes do not, therefore, erect your factory on an elevation.

ERITREA, NORTH AFRICA.

In the Annual Report for 1926, issued by Messrs. Wigglesworth and Co., the possibility of Eritrea, the Italian Colony, starting sisal plantations was discussed. The production is still very small and likely to be absorbed by Italy itself. Whether or no, or how soon these colonies will become noticeable suppliers of sisal, and so cause Italy to be more independent of other growths, remains to be seen.

* * * *

From the Annual Report for 1928 of the same firm, let us borrow the following :

ESTIMATED PRODUCTION OF HARD FIBRES.

	1928 Tons	1927 Tons	1926 Tons	1925 Tons
Philippine manilla ...	175,000	161,343	155,250	156,625
Philippine maguey ...	16,000	17,385	18,138	25,330
Mexican henequen ...	127,000	120,000	110,000	111,400
Java and Sumatra sisal	46,000	44,000	38,000	35,000
African sisal ...	52,000	50,000	40,537	36,000
New Zealand hemp and tow ...	15,000	21,896	29,750	18,545
Bahama sisal ...	1,500	1,500	1,800	2,500
Jamaica ...	1,000	1,000	1,500	1,000
Mauritius ...	1,000	800	700	1,000
	434,500	417,924	395,675	387,400

* * *

Those having to trust to bulbils for planting at first may like to know that one pole can yield 2,000 bulbils, more or less. Various reports exist as to what height the poles run up to, even 40 ft. being mentioned, but 25 ft.—which they can reach in about three months—seems a usual height.

* * *

With respect to sisal production in the Bahamas, from the Surveyor-General's office at Nassau we have received the following note: "The original plants were first introduced from Yucatan in the middle of last century. Later, by the endeavours of Governor Sir Ambrose Shea, about 1889, the growing of sisal was started as a commercial enterprise. Foreign capital was interested in the venture, and for the first few years a small bounty was paid on all sisal fibre exported. A certain number of large sisal farms were started and machinery for extracting it was installed, but these operations on a large scale were not financial successes and ceased operating after a few years.

"The native farmer or peasant proprietor was encouraged to plant out sisal and extract the fibre by hand, and this is now the only source of sisal

production in the Colony where the peasant proprietor sells his production in small quantities to merchants who bale and export it; whilst to prevent the export of unsuitable fibre a salaried inspector exists.

"During the year ending December 31, 1926, the export of sisal fibre (Bahamas hemp) amounted to 1,693 tons valued at £40,082, but in 1927 the export was only 596 tons valued at £10,632."

Coming right up to date, the following table of values, again borrowed from Messrs. Wigglesworth's Annual Review for 1928, is worth remembering.

FIBRE VALUES (PER TON) IN THE UNITED KINGDOM ON JANUARY 1 OF EACH YEAR.

	1929	1928	1927	1926	1925	1923
Jute, First Natives ...	32 10	31 0	31 10	57 0	39 10	26 0
Manila J. (U.K.) ...	39 10	42 0	46 10	46 0	56 0	35 5
New Zealand, Fair ...	34 10	33 10	36 10	36 10	42 0	32 0
African sisal, No. 1 ...	42 0	37 0	42 0	45 15	48 10	36 10
Cebu maguey, No. II...	34 10	32 10	38 0	40 0	39 10	—
Manila maguey, No. II	34 0	32 0	37 0	38 10	38 10	—
Mauritius hemp, Prime	39 10	37 10	35 10	44 10	48 0	31 10
	Per lb.	Per lb.	Per lb.	Per lb.	Per lb.	Per lb.
Mexican henequen ...	6½c.	6½c.	7¼c.	9½c.	8¾c.	7¼c.
Cotton spot, Liverpool	10.59d.	11.05d.	6.89d.	10.27d.	13.50d.	7.11d.

Commenting on the fibres themselves, Messrs. Wigglesworth pointed out that with:—

African Sisal.—In the early months of 1928 the market pursued an even course, with little or no fluctuation in price. A sharp, though temporary, decline ensued and lasted during the quiet summer period, giving rise to belief in an over-supply of sisal, coupled with an abundance of manila and other hard fibres. This has proved to be a fallacy and many consumers have been misled as a result.

Exceptional grain harvests throughout the world created an entirely new situation, and brought about a demand of an unprecedented nature, leading spinners

to anticipate their requirements for over a year ahead. Prices have responded to continuous buying to the extent of £9 per ton advance since August, and despite the volumes of sales the movement has apparently not yet exhausted itself.

Although low prices brought a temporary check to production in some areas, present values may possibly bring about the healthy expansion in output that is required to meet the ever-growing demands of the world for this fibre, which is gradually displacing other materials, since improvements in machinery are enabling manufacturers to produce finer ply twines than were formerly possible.

Sisal Tow.—A persistent demand has absorbed the entire production, thus proving the popularity of the twines made from it, which are continually finding new uses. Values, though usually very steady, have latterly shown a sympathetic advance.

Mexican Sisal.—This fibre has taken its share in meeting the requirements of the record cereal crops, and a gradual but healthy development of the industry is looked for, the production being marketed on very sound lines with a view to stability of value.

The Magneys.—Opening at £32 10s. for Cebu and Manila 2's, values receded in ten months to £27 10s. for the former. A strike at Cebu caused a temporary shortage and brought a rapid reaction, the loss being regained and surpassed within a few weeks. Although Japanese consumption decreased, Europe and America held their own, the lower prices proving attractive to spinners. Production is sparse, hence stocks both here and at origin are negligible, so that occasionally a scarcity, especially of Manila 2's, has made itself felt. The highest points touched during the year were £34 10s. and £34 per ton respectively, while Cebu and Manila 3's registered £33 and £32. The advance has been maintained and we close with values at this level.

Java Sisal.—After an uneventful first half of the year this market had quite an exceptional advance in prices which, however, became stabilized by sales effected for long periods ahead.

Mauritius Hemp.—This trade is in course of development on a sounder footing, based on new and approved standards of quality and the fibre is being introduced into new uses with satisfactory results. The volume of business, though small, is increasing. A noticeable feature has been the difficulty of obtaining supplies of the higher qualities.

With Manila hemp, the same report told us, Japan has shown a wonderful expansion in her requirements, so that there is nothing more remarkable than the steady increase in the consumption of Manila fibre by this island nation, both for paper and rope making purposes. The actual figures for 1928 were 321,000 bales against 259,000 in 1927 as compared with the U.K. which took 349,000 bales against 335,934 in 1927, whilst 224,000 bales (against 151,098 in 1927) went to the Continent. The total receipts at Manila amounted to 1,400,000 bales, which was about 10 per cent. above the total for 1927. Owing to supplies exceeding the demand prices went back during 1928 as under :—

Grade	S1	from	£66	10s.	to	£44	c.i.f.
"	J ²	"	42	"	32	10s.	c.i.f.
"	K	"	39	"	29		
"	L ²	"	36	"	23	10s.	c.i.f.

NYASALAND.

In 1927, there were 6,282 acres under sisal as compared with 6,212 acres in 1926, and 988 acres in 1917. This crop is one of the least dependent on a regular rainfall and has the added advantage that it is comparatively free of pests and diseases.

SOME KENYA STATISTICS.

According to the Ninth Annual Agricultural Census for the Colony and Protectorate of Kenya (for 1928) the following comparative table of ratio of acreage under cultivation to total acreage occupied reflects the sustained and satisfactory progress of agricultural pursuits over there :—

Year	Total occupied area	Total cultivated area	Total area under crops as at July 31	Total area cultivated but not planted as at July 31	Percentage cultivated to occupied land as at July 31	Percentage cropped to cultivated land as at July 31	Percentage fallow at July 31
1928	4,996,406	592,741	525,421	67,320	11·81	88·64	11·36
1927	4,737,920	512,543	438,035	74,508	10·82	85·46	14·54
1926	4,587,817	463,854	401,041	62,813	10·11	86·46	13·54
*1925	4,420,573	392,628	324,331	68,297	8·88	82·61	17·39
*1924	4,192,731	346,988	297,337	49,651	8·28	85·69	14·31

* The Census periods for the years 1924 and 1925 was July 1 to June 30.

Of the above, the percentages of areas under the principal crops to total areas under cultivation work out as follows :—

Crop	1928 %	1927 %	1926 %	1925 %	1924 %
Maize	36·4	37·5	41·7	39·7	40·7
Coffee	14·2	14·6	14·9	16·6	17·3
Sisal	15·5	13·9	13·0	13·4	13·1
Wheat	14·9	12·8	9·4	5·4	6·0
Coconuts	1·3	1·5	1·9	2·3	2·6
Sugar Cane	1·6	1·3	1·4	1·7	1·5
All other crops	5·9	4·8	4·9	5·0	6·4
Total	89·8	86·4	87·2	84·1	87·6
Land under cultivation but not sown	11·4	14·5	13·5	17·4	14·3
Total	101·2	100·9	100·7	101·5	101
Less Catch Crops	1·2	0·9	0·7	1·5	1·9
	100 %	100 %	100 %	100 %	100 %

PERCENTAGE CROP DEVELOPMENT TO CULTIVATED AREA.

	Developed area under crops. Acres	Maize Per cent.	Coffee Per cent.	Sisal Per cent.	Wheat Per cent.	Coconuts Per cent.	Sugar Per cent.	All other crops Per cent.	Fallow Per cent.	Less catch crops Per cent.
KENYA COLONY.										
COAST PROVINCE.										
Digo ...	4,798	—	—	43'3	—	35'0	6'0	1'5	15'8	1'5
Lamu and Tana	2,344	—	—	—	—	100'0	—	—	—	—
Malindi ...	6,809	6'2	—	45'8	—	36'4	—	16'4	4'5	9'3
Mombasa ...	2,691	—	—	44'6	—	55'4	—	0'1	—	0'1
KERIO PROVINCE.										
Ravine ...	13,273	38'4	2'0	—	46'0	—	—	0'7	13'0	0'1
KIKUYU PROVINCE.										
Embu and Meru	26	3'8	30'8	—	3'8	—	—	23'1	38'5	—
Fort Hall	49,404	2'7	32'9	57'3	1'2	—	—	0'7	6'5	1'3
Kiambu ...	67,952	1'8	45'5	31'3	—	—	2'2	11'5	8'6	—
NYANZA PROVINCE.										
Kavirondo North	1,060	8'5	84'4	—	—	—	—	4'7	4'1	1'7
Central	285	1'1	15'1	64'9	—	—	7'0	4'9	7'0	—
South	34	41'2	32'3	—	—	—	—	35'6	2'9	12'0
Kericho ...	10,184	8'5	45'8	—	0'3	—	—	38'5	10'3	3'4
Nandi ...	2,013	33'4	62'8	—	—	—	—	0'5	19'6	16'3
UKAMBA PROVINCE.										
Kitui and Machakos	20,547	1'8	2'5	45'7	15'8	—	0'4	4'2	29'7	0'1
Nairobi	5,105	8'0	20'0	43'8	1'9	—	—	10'4	15'7	—
Teita ...	9,124	1'5	2'4	64'1	—	—	—	1'2	30'8	—
EXTRA PROVINCIAL DISTRICTS.										
Kisumu-Londiani	36,148	28'5	24'0	9'2	10'6	—	20'5	1'7	9'6	4'1
Laikipia	5,666	25'7	1'1	—	49'1	—	—	5'9	18'2	—
Naivasha	19,904	3'9	—	25'5	32'8	—	—	13'6	24'2	—
Nakuru	134,062	56'1	1'1	3'5	25'3	—	—	6'5	7'5	—
Nyeri...	11,944	4'2	34'5	1'0	25'8	—	0'1	3'9	30'0	0'1
Trans Nzoia	92,186	78'2	9'1	—	2'1	—	—	2'6	9'5	1'5
Uasin Gishu	97,182	46'4	5'6	4'9	36'8	—	—	5'5	12'7	1'9

The preceding table shows the relative importance of the more important crops in each area.

The area placed under sisal increased in 1928 by 20,696 acres, equivalent to 29.06 per cent., as compared with 18.30 per cent. of the previous year, and is the greatest annual increase so far recorded in this industry. The estimated production for the year 1928-29 is given at 365,000 cwt. (18,250 tons). Here we have a comparative table showing the "cutting" acreage and export therefrom:—

Year	Area over 3 years Acres			Export Cwt.
1927-28	...	48,621	...	290,190
1926-27	...	40,751	...	310,988
1925-26	...	36,538	...	277,400
1924-25	...	35,610	...	255,772
1923-24	...	27,137	...	207,873

The above substantial increase in "cutting" areas is evidence of the progress of the sisal industry, which is also reflected in the export figures.

With regard to the comparative percentage of the chief crops, the three leading industries compare as under:—

		1927/28 Per cent.		1926/27 Per cent.		1925/26 Per cent.
Coffee	...	49.8	...	32.4	...	35.8
Sisal	...	11.3	...	22.4	...	24.4
Maize	...	10.3	...	22.0	...	12.6

In 1925, Kenya Colony returned as existing twenty-seven sisal factories with an output of 76.5 tons per day. In 1928, the number of factories had increased to thirty-seven and their output to 107 tons per day.

According to the Agricultural Census (p. 42) the total areas in Kenya Colony planted to sisal, the age and actual yield of the plants during the twelve months ending July 31, 1928, were:—

	Total area planted on July 31, 1928 (excluding areas where cutting has been completed)	Age of plants		Actual production from August 1, 1927, to July 31, 1928
		Up to 3 years	3 years upwards	
KENYA COLONY—	Acres	Acres	Acres	Tons
1925	52,872	17,262	35,610	11,091
1928	91,909	43,288	48,621	14,737
COAST PROVINCE	6,390	1,779	4,611	1,392
Digo	2,075	575	1,500	100
Malindi	3,115	1,204	1,911	1,160
Mombasa	1,200	0	1,200	132
KIKUVU PROVINCE	49,727	25,529	24,198	7,008
Fort Hall	28,342	13,907	14,435	4,225
Kiambu	21,385	11,622	9,763	2,783
NYANZA PROVINCE	185	185	0	0
Kavirondo—Central... ..	185	185	0	0
UKAMBA PROVINCE	17,483	4,937	12,546	4,861
Kitui and Machakos... ..	9,392	1,022	8,370	3,277
Nairobi	2,240	1,730	510	145
Teita	5,851	2,185	3,666	1,439
EXTRA PROVINCIAL DIST.	18,124	10,858	7,266	1,476
Kisumu-Londiani	3,351	1,887	1,464	263
Naivasha	5,100	2,500	2,600	500
Nakuru	4,682	3,182	1,500	270
Nyeri	200	200	0	0
Trans Nzoia	3	1	2	0
Uasin Gishu	4,788	3,088	1,700	443

SOUTH AMERICAN NEWS.

According to Joseph Agan, writing in the *Journal* of the Pan-American Union about March, 1920, the *Fourcroya gigantea*, known locally as Piteria, was common in Victoria, around the bay. This fibre was cultivated by the Dutch in the seventeenth century, and they probably carried plants to Asia and Africa. Leading botanists have suggested that these *fourcroyas* are indigenous to Central America or the West Indies, where they are or were known as *cabuya* or *cabulla*. Wherever it comes from, it can be found to-day in many places and soils in Brazil.

With regard to its yield, these (*fourcroya*) plants

are said to have given forty leaves yearly, running ten to twelve feet in length, yet the yield of fibre was no greater in weight per 1,000 leaves than that of the true sisal. This plant, it was thought, could "prove the salvation of the inhabitants of the bleak, sandy wastes of Ceara and elsewhere."

Another account speaks of large growths of Pita in Brazil, but in this case Mauritius hemp is meant, and the name Pita is used at random for more than one kind of fibre. Sisal has been mentioned as cultivated at Sao Sebastiao do Cahy in Rio Grande do Sul, but here is a talk also of Pita, so one wonders if the true sisal is more than a name. In any case the output cannot have been large and was all consumed locally. Most of the producers of Brazilian fibres seem to regard Indian jute as their chief competitor. This suggests that most of the Brazilian fibres so far tend to run "soft."

HAYTI.

Whilst preparing the section on Cuba for press, I am reminded of quite another portion of the tropics which has apparently turned to sisal production at the instigation of buyers in the United States, viz., the island of Hayti in the West Indies. We are told, in the report on Hayti (p. 29) to September, 1928, sent to me by the Department of Overseas Trade, that this Republic is making every effort to increase the industrial production of the country. Apart from the present chief crops (coffee and sugar), cotton and sisal are being planted with considerable success. Several sisal companies have been formed with American capital and, while it is yet too early to state definitely what success has been achieved, the results would appear to be satisfactory.

PORTUGUESE EAST AFRICA.

On April 10 (1929) a statement published in the *Times*, concerning the production of sisal on a large scale on land near Mazimbwa or Mocimboa in Portuguese Nyasaland, estimated that the cost per ton c.i.f. would be £20, if 3,000 tons of sisal at least were produced and exported. This is a reminder that the postal stamps of the Cia. da Moçambique carry an excellent illustration of a sisal estate with a man standing on the light railway track which runs between the plants.

PHILIPPINE ISLANDS.

In a letter dated April 27 (1929) when discussing the decortication of abaca or Manila fibre, Mr. M. M. Saleeby, the United States fibre expert, wrote me as follows:—

“ This fibre is obtained from the stalk of the plant. Contrary to outside opinions, the mid-rib and the petiole of the abaca leaf do not yield a commercial fibre, which is obtained from the leaf-sheaths which form the stalk, the construction of which is identical to that of the banana plant. For this reason it is unlikely to be feasible to decorticate the fibre by the crushing method used in sugar cane, as has been suggested. Any modern method of decorticating abaca fibre on a large scale and in the most economic manner, must consist in first separating the stalk into its component leaf-sheaths. The sheaths can then be treated in the same manner as sisal leaves, although the structure of the two is quite different. Actual extraction can be accomplished by either of the two methods, viz., by the ‘beating’ process used in modern sisal machines, or by a ‘scraping’ process. The first of these, i.e., the beating process, would not be as effectual with abaca as it is with sisal, owing to the fact that the

pulp surrounding the fibre is not as brittle in abaca as in sisal. The 'beating' process, however, would seem to be the easier process to develop, and machinery designed on this process would probably give a much higher yield of fibre and could, perhaps, be devised to suit a large capacity of production. On the other hand, against this increased quantity, the "scraping" process would undoubtedly give a much higher quality product, but machines based on this process would probably be difficult to devise to give a large capacity of production, and consequently would cause considerable waste. Whether this higher quality would compensate the planter or shipper for the larger yield by the "beating" process is a problem that has yet to be solved."

Those who want to follow up this subject will find that Mr. Saleeby has written fully on "Abaca Production and Preparation," in the *The Cord Age* of New York (114, East 32nd Street). There you will read that the mature abaca plant consists of several stalks ranging from six to twenty or more. Each stalk is built up of a central core which is fleshy and fibreless, and the sheaths enveloping it are merely extensions of the stems or petioles of the leaves. A cross-section of the sheath shows it to consist of three distinct layers. The outer layer is a fibrous ribbon, known as the "Tuxy," and it is from this that the commercial fibre is produced.

To prove, if proof is needed, how up-to-date the information in this book is, it will be both interesting and instructive to note that, whilst working on the Index, the following letter, dated June 14, 1929, was received from Sir David Prain, to whom I am indebted for much knowledge and many kindnesses since we first met soon after his appointment to the Directorship of Kew. I would like to add that Dr. Hill, the present Director, has always shown an equal willing-

ness to help me obtain information to round off rough corners when shaping some article for my own paper or other periodical. "Kew" may occasionally have a "firework display" of publicity, although I cannot recall one, but those who know the Department and its staff best will be the first to say that even those "in the swim" do not always know until afterwards the steady, plodding, and persistent work that is always going on in the Gardens for the good of the Empire and of the world at large.

Writing, in this case from the Imperial Institute in answer to a query I had raised, Sir David Prain said, "I do not think the solution of the problem, as to the present position of the sisal waste question, which Dr. Ernest Goulding of the Imperial Institute has at his fingers' end, can be on the lines of that of the banana question, though it may be applicable to the Manila one. No doubt both the Manila hemp and the banana are derived from two very similar plants, but in the one case it is the fibre one wants, whilst in the other it is the juice of the stem (to feed the plant and subsequently the fruit).

"If one may judge from what has been done in other cases, it appears to me that the avoidance of Panama disease is most likely to be accomplished by the 'breeding' of a strain of banana which is immune against the disease and at the same time can yield a good marketable fruit. This may take a long time and cannot fail to cost a lot. But once it is done, it is done, and when done, things should go straight. The maintenance of health is a better object to aim at than the cure of disease."

* * * *

As a result of further correspondence on the subject I believe I am right in saying with regard to the production of alcohol from sisal refuse that, as stated in Chapter XII of this book, the possibility of producing

alcohol from the leaf waste as it comes from the decorticating machinery has received considerable attention, especially in Mexico. I now know that the article referred to in Chapter XII was originally contributed by Monsieur F. H. d'Hérelle to the *Journal d'Agriculture Tropicale* (1910), p. 161, and was translated into German for *Der Pflanze* by Lommel.

The first industrial investigations to obtain alcohol from the residues left after decorticating agave leaves were carried out by M. Dorcas, a Mexican engineer of French origin, together with M. Alilaire of the Pasteur Institute.

A little later M. d'Hérelle was engaged by the Mexican Minister of Agriculture to undertake industrial trials in the same connection. These are the trials described in Chapter XII. They proved successful, and a factory was built at Merida in Yucatan and operated for about two years, when, owing to political unrest and changes in the Ministry of Agriculture, the work was discontinued.

M. d'Hérelle subsequently entered into relations with M. Dorcas, and a Franco-Mexican Society was formed with a view to the exploitation of the immense agave plantations in Coahuila in the north of Mexico. All the necessary plant required for the factory was assembled and sent to Mexico, but by the time of its arrival disturbances in the country had developed to such an extent that further progress with the scheme became impossible.

With reference to the statement on p. 243 that "three more similar distilleries have been erected," this, I am told, is an error due to mistranslation, and that the original note in *Der Pflanze* tells us that it was merely suggested that two or three more distilleries should be erected. So far as I know, these factories have never been established.

The latest suggestion, apparently having to do

with the manufacture of alcohol from sisal waste, is that which has been put forward by M. Robert Fouque. A company, known as Sisaleraies et Carburants Africains, has been formed in Paris to acquire the exclusive rights of this process in French West Africa. It is claimed that from a decorticating plant treating 400 tons of leaves daily, about 2,530 gallons of alcohol would be obtainable at a cost not exceeding 6d. per gallon. The process depends on the collection of the juice from the leaves and its subsequent fermentation. For this purpose the waste from the leaves is submitted to pressure in order to express the juice, and the dry waste remaining after this has been effected is converted into fuel for gas producers, whilst an excellent manure is said to be recovered as a by-product of the distillation and other processes.

In connection with this process it may be pointed out that sisal producers in East Africa employ machines which crush and scrape the leaves whilst a stream of water which is carried over the fibre washes away the leaf refuse, at the same time carrying away all the juice. Hence some claim that in order to retain the juice for subsequent fermentation it would be necessary for fibre concerns in East Africa to replace the whole of their machinery, an expense which apparently they are not prepared to entertain. This claim, in any case as regards "the whole of their machinery," surely does not hold good, but whether it does or not is for the planters and the engineers, not the writer, to say.

Before leaving this subject it will be as well to add the following comment on the suggestions put forward on p. 246.

(1) The water on removal from the waste fibre would carry away practically the whole of the sugar and acids. The use of this water for washing further

quantities of fibre would be very objectionable as it would reintroduce the acid substances which the main object of the washing is to remove.

(2) The separation of the broken fibres from the leaf refuse would be a difficult matter and would probably require too much handling to render it feasible on a commercial scale.

(3) As pointed out under (1), the sugars are dissolved in the juice and on removing the juice are therefore eliminated, so that the residue would be of no value for fermentation unless possibly fermentable sugars could be produced from it by some form of acid hydrolysis.

The problem of disposing of the enormous quantities of leaf refuse produced in the neighbourhood of a sisal factory is one of great importance to the producer, and so it may perhaps be well to draw your attention to a method of utilizing the leaf waste as manure, which Dr. Goulding tells me has been described by Dr. Richard Hindorf in "*Der Sisalbau in Deutsch Ostafrika*" (Berlin, 1925),¹ from which the following notes are extracted:—

The leaf residues from the decorticating machine contain in the fresh state more than 80 per cent of water, and 4 per cent. of mineral, and 2 per cent. of nitrogenous constituents. On some plantations the dried heaps of leaf refuse are slowly burned to ashes and the ashes applied as manure, but usually this plan is only partially successful, as the residues are both difficult to dry and difficult to burn. Dr. Hindorf considers, however, that such practice is on the right lines, and suggests that the best plan is to combine the incineration of the refuse with composting. The leaf refuse should be spread out on large sloping

¹ Those able to read German should secure a copy of this book if they have not already done so. It is written by the man who introduced sisal to East Africa and his knowledge on the plant, its likes and dislikes, must be exhaustive.—H. H. S.

places where the water will quickly drain away, so that the greater part of the material soon becomes dry enough to burn. The lower layers of the refuse become baked together into moist lumps which will not burn. These lumps, together with the ashes, are taken to adjacent places where manure is stored and are there spread out with all other kinds of waste which may be available to form compost heaps. To these heaps may be added the ashes from the boiler fires, the sweepings from the brush room, as much cattle dung as possible, and also, if available, night soil which has already been made into a solid mass in the pits by the copious admixture of wood ashes and vegetable refuse; there may also be added bones, maize stalks and cobs, and, in short, all the refuse from the house, yard and factory may be used for composting. The heaps must be stirred up from time to time so that the whole contents become well decomposed and uniformly mixed. Compost heaps which are made and treated in this way yield a highly valuable manure suitable for all purposes. If cow dung can be obtained from natives in the vicinity a generous admixture of this with the compost will increase the value of the latter considerably.

Dr. Hindorf suggests that from the point of view of the utilization of the leaf refuse as manure it would be of great advantage if portable machines were used for the extraction of the fibre.

* * * *

With reference to the effect of leaving the trash on the ground in banana plantations and the relation of this practice to the occurrence and spread of the Panama disease, I understand that the experts at the Imperial Institute are looking into the matter very carefully. My idea of the Imperial Institute leads me to feel sure therefore that from time to time we shall receive reliable, up-to-date information on the matter,

information which everyone at all interested in tropical crop-raising is certain to welcome and to study carefully. The fact that, with the help of Dr. Goulding, I have been able to make this addition concerning Dr. Hindorf and his work, and also of the Fouque process, is a proof of how closely they follow what is being done, and how ready the Institute is to pass on such useful knowledge to others, as they have done in my case.

From Marseilles, Colonel Standen, who in the summer of 1928 called my attention to the Fouque process, writes to complain of the little attention given to the matter in the British Colonies. "When in Paris recently," he wrote about mid-June, "I visited M. Fouque in his laboratory and was pleased to learn of the progress made in the application of his process for the extraction of alcohol from sisal waste. It would seem, however, that every producing centre is keenly interested in the matter except the British Colonies. Why are they not interested as well? A planter from Mexico was delighted to find that his sisal waste gave a yield of 15 per cent. in alcohol. M. Fouque tells me that an extensive plant is in course of erection in the French Sudan on the banks of the Niger, where important sisal plantations are being laid out. When these lands come into bearing and the cost of production is lessened by utilization of the waste, his process should have an important effect upon the cost of, and through that upon the demand for, the world's supply of fibre."

The above 15 per cent. of alcohol in fibre waste one feels must be from pure sisal juice without any added water. In any case, surely such a return is too high to be reliable for commercial records. Compare it with the returns on pp. 237, 238 earlier in this book.

RELATION BETWEEN BANANA TRASH AND PANAMA DISEASE.

Following the above came another very important letter from Dr. Goulding, proving how carefully he had followed up my line of argument, and brought it to a conclusion which I could not have done. In calling attention to the following reports from Jamaica I would like to emphasize the importance of removing the stems as well as the leaves from the estate, and whilst still fresh, for if the dry leaves can carry the bacteria of Panama disease in the way described, it is easy to imagine how the stems and leaves left on the ground are infested. Far better surely to clean up and lightly cultivate the land as often as possible, if by utilizing the fibre and also the liquor for alcohol the cost of doing so can be done to pay in the long run.

In continuation of my letter of June 18, he wrote from the Imperial Institute, "We have now looked into the question regarding any possible relation between the trash on the ground in banana plantations and the spread of Panama disease. The recorded evidence appears to show that *infected trash is a definite factor in the spread of the disease*, and I have pleasure in enclosing a short memorandum on the subject."

Mr. C. G. Hansford, Government Microbiologist, Jamaica, in a Circular on "Panama Disease in Jamaica," issued by the Department of Science and Agriculture, in 1926, discusses the various means by which the disease is spread. In respect of banana trash, he makes the following statement:—

"Abundant evidence from field observations during the past few years in Jamaica has been accumulated indicating that banana trash has spread the disease far and wide. The dry leaves of the banana were until recently used for packing

all descriptions of agricultural produce, and were distributed all over the island from the infected districts.

"The field evidence has been corroborated by the results of certain inoculation experiments carried out at the laboratory. Banana trash was taken from diseased banana plants and placed in tubs of sterilized soil in which banana plants were growing. After some months these plants died from the disease, indicating that the banana trash had carried the organism with it."

With a view to preventing the removal of trash liable to carry disease to healthy banana cultivations, the Jamaica Government have issued an Order under "The Protection from Disease (Plants) Law 1925" prohibiting the use of banana or plantain trash or banana or plantain leaves for packing or wrapping purposes, except for packing bananas which are being transported to a licensed buying station or railway station yard and which are intended for sale for export from the island. All such trash or leaves used for this purpose must be burnt within twenty-four hours of being deposited at the buying station or other place. Restrictions are also placed on the removal and deposition of banana and plantain trash or leaves outside such prescribed places.

* * * *

Since receiving the above, the following details, published, I believe, in a Montreal paper, were sent by Lieut.-Col. Hargrave Standen, to whom reference is made on p. 286 concerning M. Fouque. These details say that "by the Fouque process, an acre planted with the sisal agave will give an annual yield of 5 cwt. of fibre and 80 gallons of industrial alcohol. The French Government are fully alive to the importance of this development, and have given every encouragement, and also financial assistance to the inventor,

with the result that in a few years' time French Equatorial Africa will not only be in a position to supply all demands for the fibre in France, but will probably be entering the world market with a good chance of success, for the revenue from the sale of the alcohol will cheapen production costs very considerably.

"Canada needs this sisal fibre which is used almost exclusively in the manufacture of binder twine: during the year 1927 the Dominion imported 33,278 tons of sisal hemp, valued at \$4,370,587.00, and 282,814 cwt. of binder twine, the value of which was over four million dollars. It is interesting to note that over 97 per cent. of the fibre and 99 per cent. of the twine came from foreign, i.e., non-British sources, the bulk being from Mexico *via* the U.S.

"Now the product of 80,000 acres of sisal plantation, the waste being treated for alcohol production by the Fouque process, would give a yield of fibre almost equal to the total annual importation, and, in addition, 640,000 gallons of motor spirit. There are hundreds of thousands of acres of land in the various islands of the Bahamas group where the soil is eminently suitable for the cultivation of the sisal agave, and which to-day lie idle. In the island of Inagua alone, 360,000 acres in extent, well-watered and fertile, there is room to raise all the sisal hemp required in Canada. Flourishing sisal plantations also exist in Cat Island and elsewhere in the Colony.

"I placed these facts before representatives of the Empire Marketing Board in London but was informed that 'the diversion of trade with a Dominion from a foreign to a British source was a matter in which they could not interest themselves, it being outside the terms of reference under which the Board was constituted.' It appeared that I should have addressed myself to Canadians in Canada, and I hope that the

matter may be of sufficient interest to warrant my asking for the hospitality of your columns to enable me to do so."

* * * *

As this book has been devoted to a discussion on the production and preparation of sisal along lines that will best pay the planter in profit, and the users of the resultant fibre in quality and lasting power, one feels that from the point of view of the planter's profits, it must be necessary to give up dumping the acid refuse on the ground or, worse still, running it off into the rivers. Surely, therefore, it was not unwise to discuss the utilization of the refuse from Manila hemp and banana waste together with that of sisal, in order to attract the utmost attention to the matter if only to see how the harmless removal of the refuse could be brought about at the least cost, if not at a profit, to the planter. If those interested in the above trio of tropical industries can now be induced to come together and discuss the matter, surely much good will result. One feels, therefore, in the face of the foregoing, that the statements sent us by Dr. Goulding form a most valuable addition to the book, and I am greatly indebted to the Imperial Institute and its able assistant for enabling me to include it. Sir David Prain spoke with a double truth when he said that Dr. Goulding had all such matters at his finger tips.

* * * *

Sisal, it must be remembered, also has its romantic side. We were reminded of this when Princess Mary, Viscountess Lascelles, laid the foundation of a new block of British Legion flats in the grounds adjoining their poppy factory at Richmond Hill. Her Royal Highness, we are told in the report, showed great interest in the making of poppies, for which sisal from Kenya was used to form the stamens of the flowers which we have come to know so well.

PART II

PREPARATION

PART II

SYNOPSIS

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PREPARATION

INTRODUCTION

THANKS to Mr. L. F. Evans (per the Secretary of the East African Sisal Growers' Association at Nairobi), we can start this section with the following details of the work as carried out in Kenya Colony and East Africa where the sisal is grown under varying conditions. Plantations exist at the Coast, the mid-Highlands, and the Highlands proper, i.e., from sea-level to an altitude of 6,000 ft., and conditions, as will be realized, differ considerably over these areas.

The coastal belt consists of sandy soil, with a humid hot atmosphere and a fair quantity of rain. The mid-Highlands are on the whole dryer as regards rainfall, the average being about 22 in. per year, but the soil is of a sandy nature. The Highlands proper, where the bulk of the sisal is grown, have a rainfall varying from 36 in. to 70 in. per annum, the soil being mostly very rich chocolate loam with some "black cotton." It will thus be seen that the sisal appears to acclimatize itself to climatic and soil conditions.

On the coastal belt it grows a longer leaf and gives a greater percentage of fibre than that grown in the Highlands, where the leaf is considerably shorter and more "fleshy," due to abundance of moisture. The coastal belts have the advantage in respect of inward and outward freights, and the climate is also more equable for the general working of a plantation in respect of native labour. The

native races in East Africa prefer hot climatic conditions for working in, and as a rule rain and cold kills any desire they may have for work. The Highlands are, however, mostly surrounded by native reserves, and are thus in a better position as regards procuring labour, that, too, at a much cheaper cost.

The Kavirondo, a tribe resident near Lake Victoria, are used in great numbers throughout the plantations. They are the most suitable native for the work owing to their good physique, whilst the extra money they are able to earn in this industry as compared to other work, such as coffee, &c., appeals to them.

A plantation should consist approximately of 5,000 acres of land, of which from 3,000 to 4,000 acres will be planted with sisal. The extra land is used for grazing and native shambas. A labour force of 300 to 400 is required, of which 200 are used entirely on production work, the remainder being employed on maintenance and development. A yearly rotation of 450 acres of planted sisal is a favourable proposition. The land is ploughed and cross-ploughed before planting, and tractors are used extensively for this purpose, the Caterpillar being the one most favoured.

Planting is done by hand, with suckers collected from existing areas which are spaced in rows 12 ft. by 4 ft. apart. This wide spacing of 12 ft. has generally superseded narrower planting, as it facilitates the cultivation of the plants throughout their lifetime.

Cultivation is carried out twice a year by tractors of the smaller type drawing disc or tyne harrows, the former being the type generally used. Weeding and de-suckering close up to the plant is done by hand in conjunction with the cultivating.

At the age of 4 years the sisal is ready for its first cutting, which yields about 60 leaves per plant,

only the lower leaves being taken. The yield of fibre from this cutting is about one ton per acre. Further cuttings are taken at intervals during the next four years, the percentage of fibre obtained increasing with the age of the plant. A total yield of three tons per acre of fibre can be expected over the entire life of the plant, i.e., in nine years from the time of planting when the plants should have died out. The land is then stumped and cleared, the old boles burnt, and the land re-ploughed and planted. This practice is, however, being superseded by inter-planting, a system which entails much less labour and cost. This is done with suckers which are planted between the original plants, after the latter have attained the age of $4\frac{1}{2}$ years, and thus, when the original planting dies out, the inter-planted sisal is coming to maturity and adds the great advantage of reducing the old nine-year cycle to five years (see p. 366).

The transportation of leaves to the factory is carried out by trucks, with a capacity of 2 tons of leaf each, and running on light rails. At present, in the majority of cases, these are drawn by oxen. One hundred and twenty of these trucks and about eight miles of railway are necessary for a 4,000 acre plantation in full production.

A factory centrally situated deals with the raw and finished material. Decortication of the raw leaf is carried out by various makes of machines, and the fibre thus produced is carried out to the drying lines close to the factory. When dry it is carried in bundles to where it is brushed, sorted and baled ready for export.

A factory consisting of two decorticators with the necessary motive power—in the case of electricity two 100 H.P. motors—six brushing machines and one hydraulic baling press, can deal with 1,200 to 1,400 tons of fibre per annum.

MESSRS. ROBEY & CO., LTD.

Discussing the extraction of the fibre from the leaf and its preparation for sale, with Commander Sherman of Messrs. Robey & Co., Ltd., of Lincoln, he told us that it involves a series of operations carried out in a central factory which must be situated in a convenient position on the estate. The following brief summary of these processes can be said to present a mental picture of the cycle of operations that will help to a better understanding of the more detailed descriptions of the modern methods and machines employed as given later on, methods and machines which have been changed from time to time until they approach as near to perfection as our present experience has enabled the engineers to make them.

The leaves having been cut from the plants, are taken to the factory by light railways, lorries or ox carts, and the first operation is that of decortication, which is the separation of the fibre from the flesh of the leaf. This is done by a decorticator, i.e., a machine fitted with a number of blunt metal blades that scrape the leaf in a longitudinal direction and strip off the flesh, leaving the bare fibres exposed.

Either during or immediately after decortication the fibre must be washed to remove the gums and acid, and any green particles of vegetable matter that remain. This done, the fibre has to be dried and, up to now, this has usually been done by exposing it to the sun, although artificial means of drying have been introduced on the several estates out East.

The fibre having been dried, is brought to the factory for brushing; this is done with a machine having some similarity to a decorticator, but fitted with beaters or bristle brushes which beat or brush the fibre. This operation removes the dust and any dried particles of vegetable matter that remain, whilst also giving the fibre a fine glossy appearance which

improves its value. Brushing also removes all the short fibres, which are collected and sold separately in the form of tow.

After brushing, the fibre is graded according to length and appearance and pressed tightly into rectangular bales by means of a baling press, care being taken not to harm the fibre. This can easily be avoided after a little practice. The object of baling is to compress it into as small a compass as possible in order to save freight, and the tow collected from the brushing machine is baled in a similar manner.

The decortication of sisal should take place as soon as possible after the leaves have been cut. If the leaves are left for any length of time the fibre becomes spotted and discoloured, which greatly reduces its value.

The structure of the sisal leaf lends itself much more readily to decortication by mechanical means than the leaves of other fibrous plants, such as New Zealand hemp, pita, &c. The fibre content of the leaf, however, is small, not averaging as the total content above 5 per cent., and it is therefore necessary to deal with a considerable tonnage of leaf to obtain any substantial quantity of fibre; 4 per cent. (a fair average return) of 2,240 lb., or 1 ton, working out around 90 lb. only.

The earliest machines used for decortication in Mexico were known as raspadors and in Mauritius as grattes. These consisted of drums, along the circumference of which were fixed a series of metal knives or scrapers (see illustration, p. 31). The drum was mounted on a shaft running in bearings and having a pulley on one end of the shaft for driving purposes. The whole was enclosed in a light metal casing, having an opening on one side in the lower half of which an adjustable plate is fitted. One end

of the leaf was inserted by the operator through the opening in front of the casing, and on the drum being revolved the leaf was caught between the knives and the plate and the flesh stripped from that end of the leaf. The operator then withdrew the leaf and, holding the fibre, decorticated the other end of the leaf. It will be seen that this process was a comparatively slow one, involving considerable physical exertion on the part of the operator. Owing to the small output obtainable with these machines they were only suitable

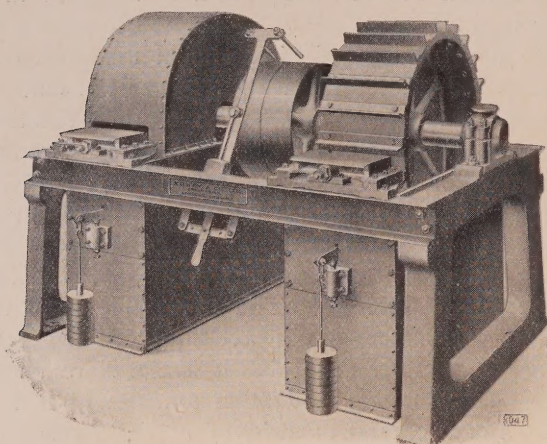


FIG. 1.—Double drum Raspador.

for dealing with comparatively small acreages, and they have been almost entirely superseded by large automatic machines in which no further handling of the leaf is necessary after it has been placed on the feed table of the machine.

Raspadors are still used on small estates up to about 500 acres, and in some cases as adjuncts to the main machinery on a large estate, as where plants in an outlying area have to be decorticated and the cost

of bringing the leaves from this area to the central factory would be prohibitive. In these cases the raspador with its own small engine for driving can be put down close to the plants which have to be dealt with. Raspadors are therefore still made and supplied for these special requirements, and fig. 1 shows a modern adaptation of these machines made by Messrs. Robey & Co., Ltd., Lincoln. This is a double drum machine with which approximately 1,500 leaves an hour can be decorticated, according to the skill of the operators. The shaft runs in ball bearings, which reduces the cost of lubrication and the necessity for any skilled attention to a minimum. The power required to drive it is approximately 9 h.p., which can best be supplied by a portable steam or oil engine. This machine is very suitable for the decortication of *sansiveira*.

PORTABLE DECORTICATORS.

Experience has proved that, owing to the small fibre content of the sisal leaf, the production of its fibre is essentially one that should be carried out on a large scale with machines capable of dealing with a heavy tonnage of leaves. The fact that approximately 100 tons of leaves have to be handled to produce three, or at the most four tons of fibre, would at first sight make it appear desirable to use a portable machine that could be taken out to the actual location of the plants from which the leaves are being cut. Such a machine would save large sums in labour involved in the transport of leaves and in the cost of the light railways, tractors, &c. Attempts therefore, it is needless to say, have been made to produce such a machine, but these efforts are said not to have met with any marked success owing to the many difficulties involved. In the first place a portable machine can only have a small output, and probably at least ten such machines would be necessary to equal the capacity of

the standard automatic decorticator as used in a central factory. Secondly, the decortication of sisal is extremely heavy work necessitating a very substantial and robust construction, if the machine is to have any reasonable length of life, and to be able to do its work satisfactorily. This necessitates a heavy carriage and involves weight which destroys the portability of the machine which is its only asset. In addition to the machine, the power plant to drive it must also be made portable, and in practice it has been found that for a machine that will give approximately one-tenth of the output of a standard decorticator, at least 15 b.h.p. must be provided and the whole outfit will weigh not less than two tons. It will be seen therefore that good roads or light railway lines intersecting the planted areas, together with motive power for hauling the machines, become a necessity. A further difficulty with such machines is the provision of water for washing the fibre during decortication and the disposal of the acid water and refuse after decortication; this is a point that is dealt with later.

AUTOMATIC DECORTICATORS.

The foregoing proves that the general experience of producers goes to show that the large automatic decorticator fixed in a central factory, conveniently situated on the estate, is the only satisfactory method of production on a commercial scale. There are comparatively few types of such machines on the market, and the broad principle of the design is the same in each type. The machine consists essentially of a travelling feed table composed of chains, belts, or ropes on which the leaves are laid transversely; it has two drums fitted with blades, and each drum decorticates one end of the leaf. The leaves are carried along by the feed table to the first drum, where each

is gripped by an automatic gripping device at a certain distance from one end. The leaves thus gripped are carried across the face of the first drum, the knives of which beat them against a concave and strip the flesh from that end of the leaf, leaving the bare fibre. Another automatic device then comes into play which grips the fibre, and the undecorticated end of the leaf is carried across the face of the second drum, resulting in the complete decortication of the leaf. It will be seen that when the leaves have been placed on the feed table no further handling is required, and the process of decortication is entirely automatic.

WASHING THE FIBRE.

If water is available in sufficient quantity, provision should be made for washing the fibre in the drums of the machine during decortication. Considerable misconception exists as to the necessity for using water during decortication, and reference is often made to machines capable of "dry" decortication. There is no necessity for the use of water in any of these machines in order to decorticate the leaf, but experience has shown that cleaner fibre is obtained if water is used to wash it during decortication and before the gums have been exposed to the atmosphere and become dry and hard. Unless clean fibre is produced a good price is not obtained, and if water for washing during decortication is not available, the fibre must be washed in tanks after it has been taken from the machine. For washing in the machine eighty gallons of water per minute is usually considered the quantity that should be provided. For many years it was considered necessary that fresh water should be used for this purpose, but a large percentage of the fibre now produced is undoubtedly washed with salt or brackish water, and this has been found to have no ill-effects either on its appearance or

quality. There is, of course, a considerable quantity of refuse from the decortication of the leaves, and if sufficient water is available the best method of disposing of this is to wash it away. For this purpose about 120 gallons per minute of water is the usual quantity provided, and channels should be made in the foundations of the machine into which the refuse can fall and be carried away by the water some distance from the factory by means of a flume. If sufficient water is not available, provision has to be made for taking trucks under the machine, into which the refuse falls and by means of which it can be carried away.

WASTE OF FIBRE.

In view of the small fibre content of the leaf it is, of course, of vital importance that the amount of fibre wasted in the process of decortication should be reduced to a minimum. It is generally agreed that the average fibre content of the leaf is approximately 5 per cent. of the weight of the leaf, but this is a very misleading method of comparison, as the leaf weight varies constantly over very wide ranges. Wet weather provides a leaf which may be very much heavier than a leaf produced during a long dry spell, and yet the actual fibre content may be the same in each case. The only reliable guide to the fibre content is the fibre weight contained by a number of leaves of given length. For this reason the percentage of fibre actually extracted from a given weight of leaves often varies from $2\frac{1}{2}$ per cent. to over 4 per cent., and a comparison of yields computed on such a basis cannot be taken as any real guide to the efficiency of any machine. The fact remains that a considerable amount of waste does occur, some of which is preventable by the employment and proper adjustment of the best-designed decorticators. Even with many up-to-date machines, however, probably 20 per cent. of the total fibre content of the leaf goes to waste.

There are two principal causes of waste during decortication, and both these occur when decorticating the thick butt end of the leaf. The least important is the loss of short fibres which have their origin in the butt end. These short fibres may be lost if the leaf is not gripped in the machine sufficiently close to that (butt) end. An analysis of several leaves has shown that, on an average, any appreciable loss from this cause will be prevented provided not more than 18 in. to 24 in. of the butt end of the leaf is decorticated in one drum when dealing with leaves from 3 ft. to say 6 ft. in length. It will be seen, therefore, that this source of loss can be obviated by an efficient design of decorticator combined with proper feeding of the leaves into the machine, and these conditions are catered for in the Robey type of decorticator which is described in detail later.

The more serious cause of loss is the breaking of fibres when decorticating the thick butt end. As has been stated above, leaves vary very much in thickness from climatic conditions, and it will be obvious that the clearance between the drum blades and the concave should be adjusted to suit these varying thicknesses. Too close an adjustment of this clearance will result in broken fibres which go to waste, while too wide a clearance will prevent clean decortication. It is therefore an important feature of any well-designed decorticator that this clearance should be capable of quick and accurate adjustment while the machine is running. The hammering action of the blades on the thick butt end is, however, bound to result in the breaking of a certain number of fibres, and although this is reduced very materially by making the process of decortication of the butt end as gradual as possible, it has not been found possible to eliminate this loss entirely and at the same time maintain a rate of output necessary to make a commercial success of fibre production.

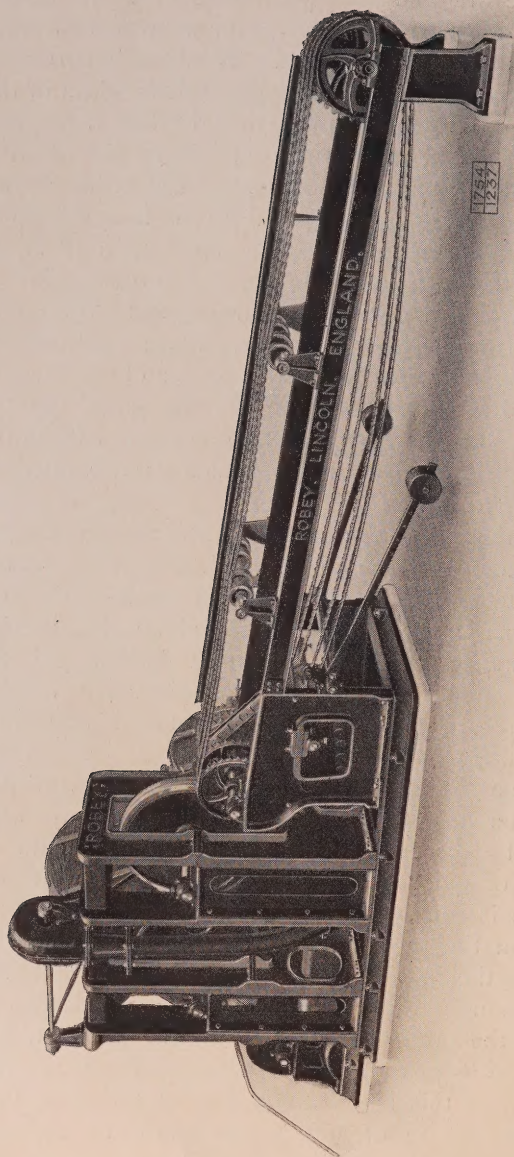


FIG. 2.—The Robey "Superdecor" showing conveyer table.

The obvious remedy for this cause of loss is to pass all leaves between crushing rolls and thus reduce them to a uniform thickness before feeding them into the decorticator. There is no difficulty in providing crushing rolls which will answer the purpose, but the difficulty is to provide an automatic feeding of the leaves through the rolls at a rate required to maintain a reasonable output. Complete decortication of the leaf by means of crushing rolls only has been attempted, and with a considerable amount of subsequent washing and brushing fairly clean fibre can be obtained by this means. The fibre so obtained is, however, of small value as, owing to the great pressure which has to be exerted by the rolls, the fibre is damaged and a great percentage of it is found to be very brittle and easily broken.



THE ROBEY "SUPERDECOR" DECORTICATOR.

Having in the foregoing given a general description of the main principles of the design of an automatic decorticator, and outlined the difficulties to be overcome and results to be arrived at, we will now give a more detailed description of one of the most modern machines. Figs. 2 and 3 show two views of the patent "superdecor" decorticator designed and made by Messrs. Robey & Co., Ltd., of Lincoln, and suitable for the decortication of sisal or Manila hemp.

Fig. 2 gives a view of the machine showing the conveyor table fitted with chains on which the leaves are placed. This table is sloped to give a low feeding end to obviate lifting of the bundles of leaves. Before entering the first or small drum the leaf is firmly gripped by a special double link phosphor bronze feed chain, which ensures that there is no loss of fibre due to slip. A small portion of the butt end of the leaf,

varying from 12. in to 18 in. according to the length of the leaf, is then decorticated by the small drum, a view of which showing the blades is seen in fig. 3. This drum is made specially wide with a long taper

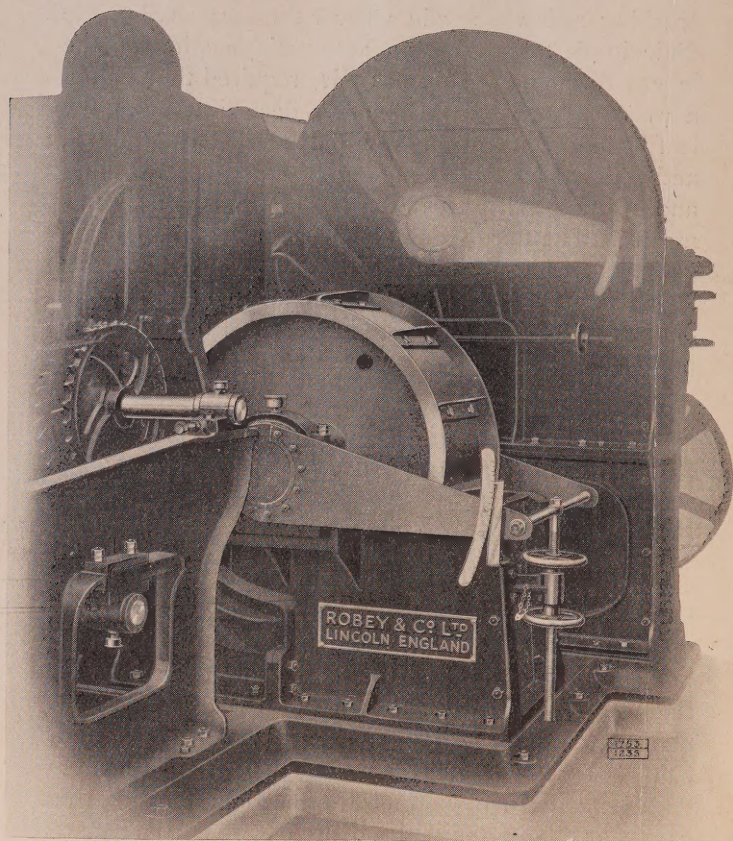


FIG. 3.—The Robey "Superdecor," showing the blades.

on the knives which results in a more gentle treatment of the leaf and a higher percentage of fibre extraction. On leaving this drum the fibre is blown by an air blast and gripped between the feed chain and second chain

wheel, while the undecorticated portion of the leaf is turned over automatically and passes between the blades and concave of the second or large drum, which completes the decortication of the whole leaf. This ingenious change-over device has the advantage of keeping both drums on the same side of the machine. Both drums of the machine are carried in roller bearings with ball thrust bearings to take the end thrust, and these bearings are carried outside the drum casings so that no water or juice can get to them. The drums are lagged with sheet brass to protect them from the acid in the leaves. Each drum is fitted with a patent concave clearance adjusting gear, which is shown in fig. 3. This device enables the clearance between drum and concave to be adjusted minutely and accurately while the machine is running, and is a most important feature of the machine.

The power provided for driving the machine should not be less than 80 b.h.p. for all normal requirements, but if heavy feeding of leaves is resorted to more power is required. The normal capacity of the machine is about 13,000 leaves per hour, the output of fibre depending on the length and condition of the leaves and their fibre content.

It is very difficult to define the actual capacity of an automatic decorticator, either in the number of leaves per hour passed through the machine or in tons of fibre produced. Extravagant and misleading figures are often quoted in this connection, and it will be obvious that as all the standard types of automatic decorticators are designed on the same broad principles, the actual number of leaves that can be passed through any machine in a given time must be approximately the same with any of these machines under the same conditions. The output of fibre is dependent on the size and condition of the leaves, but the number of leaves that it is possible to deal with in a given time is

dependent on the speed at which the feed table is run, the number of men employed in arranging the leaves evenly on the table, and the power available for driving the machine. If plenty of power is available, it is quite easy to feed the machine heavily and to allow several leaves lying one on top of the other to pass through the machine instead of having a single carpet of leaves, but this over-feeding, though it may lead to a large output, always results in a great deal of waste and bad decortication.

With the Robey "superdecor" properly adjusted and in good running order the amount of waste can be reduced to a very low figure.

DRYING.

The fibre having been washed either in the decorticator or in tanks after decortication, it must now be dried, and sun drying is the most usual means adopted. The drying field consists of a series of wires stretched between poles close to the factory, and the wet hanks of fibre are carried to the field on poles and left to dry in the sun on the wires. As drying occupies considerable time, artificial drying has been resorted to on a few estates. This drying plant consists firstly of centrifugals or squeezing rolls into which the fibre has to be placed in order to expel the surplus moisture and reduce the moisture content to about 50 per cent. The fibre is then placed on a conveyor in the drying chamber which is steam-heated. The fibre is conveyed slowly through this chamber, the initial temperature of which at the feeding end is about 230° F. At the far end of the chamber a "cooling field" must be provided to bring the temperature of the fibre back to that of the outside atmosphere before it is taken out of the chamber. The time occupied by the fibre in the drying chamber is approximately thirty minutes. The amount of steam required for an artificial

dryer of this type is considerable, and unless the factory is being driven by a steam-power plant having a good margin of surplus steam, a special boiler would have to be provided. An artificial drying plant capable of dealing with $2\frac{1}{2}$ tons of dry fibre in twelve hours requires approximately 1,000 lb. of steam per hour at a pressure of 45 lb. per sq. in. and the horse-power required for working this plant is 12/15 b.h.p. As the capital cost of the centrifugals, drying chamber and accessories is heavy, amounting to approximately £2,000, it is doubtful whether artificial drying is an economical proposition except in localities where there are considerable rainy periods when sun drying is impossible and where cheap fuel is available for producing steam for the dryer. It is doubtful if there is any saving in labour in the use of artificial dryers as compared with sun drying, but there is a very considerable saving in time. A great deal of this saving in time can be obtained by the use of centrifugals or of squeezing rolls for expelling the surplus moisture, the final drying being done in the sun. There is, however, one claim made by the advocates of artificial drying which if substantiated would turn the scale in their favour. This claim is that no brushing of the fibre is necessary where artificial drying has been adopted and that as good a price can be obtained for unbrushed artificially dried fibre as for well brushed sun-dried fibre. If brushing can be dispensed with, certainly there would be a great saving in the cost of labour and machinery to compensate for the cost of the drying plant, but it is not likely that the unbrushed would sell as well as the brushed fibre. On the other hand there is undoubtedly a certain amount of fibre wasted on the drying ground, but against this has to be set off the loss due to the lower price of the tow produced by the brushing machines.

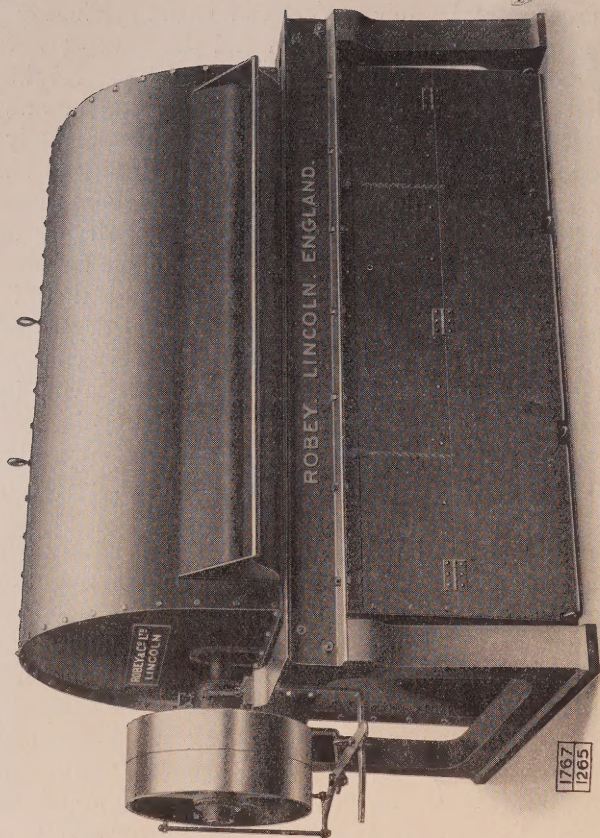
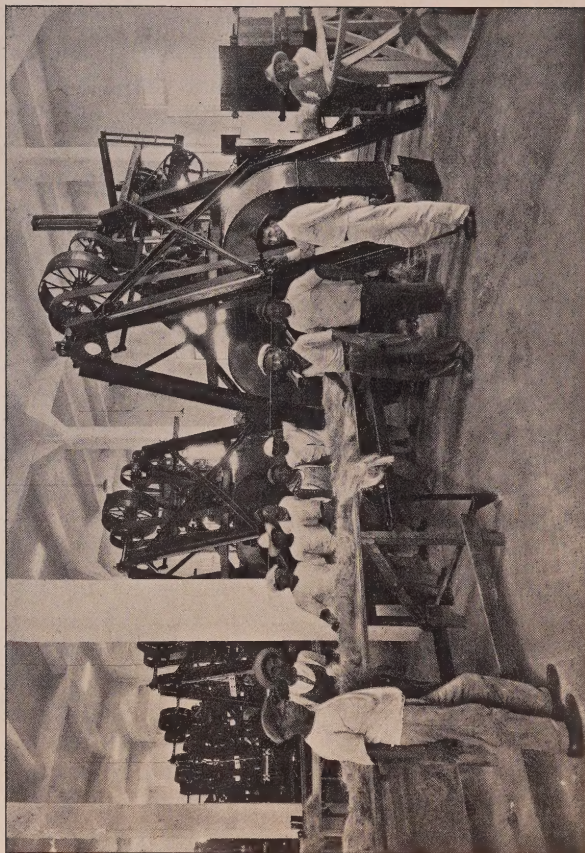


FIG. 4.—A Robey hand-brushing machine, 42-inch by 72-inch.

BRUSHING.

On the whole, therefore, one must agree that the fibre should be brushed if the best prices are to be realised. A considerable quantity of unbrushed sisal is sold, chiefly by Mexican producers, but the increase in price for brushed over unbrushed sisal cannot be ignored; it more than repays the extra cost. Two different types of brushing machines are used, viz., automatic and hand-fed machines, the former being considerably more costly than the latter. There is a good deal of misconception as to the relative advantages of the automatic and hand-fed machines. The former work very much on the same principle as the automatic decorticator, and consist of a travelling conveyor table on which the hanks of dry fibre are laid and by means of which the fibre is carried across the face of two or more revolving drums fitted with beaters, bristle brushes or combs. The simplest and cheapest type of automatic brusher has two drums only, placed opposite each other and revolving in opposite directions. The hanks of fibre are gripped in the centre and carried across the face of the drums, each end of the hank being brushed by the revolving drums.

Owing to the relatively small advantages to be gained by the use of automatic brushers as compared with hand-fed machines, and the very much greater first cost of the former, the great majority of sisal producers use hand-fed machines. These are built very much on the lines of the raspadors already referred to, and consist of a revolving drum to which are fixed beaters, brushes or combs, and enclosed in a light metal casing. Each hank of fibre is inserted into the mouth of the machine, and one end is held by the operator while the other end is brushed, the hank then being reversed until the whole has been treated. The short fibres that are separated from the



By courtesy of

Messrs. Robey & Co., Ltd.

FIG. 5.—A battery of British Brushing Machines (electrically driven) in Yucatan.

hanks during the process of brushing fall to the bottom of the machine and go to form tow. These machines are sometimes supplied with concaves against which the drums brush the fibre in a downward direction, but in the most usual form of machine the fibre is brushed upwards, only the weight of the fibre making it keep in contact with the beaters or brushes. Fig. 4 shows the latest form of hand-brushing machine made by Messrs. Robey and Co., Ltd., which provides some interesting features.

This machine consists of a single drum, 6 ft. long by 42 in. diameter, which is mounted on a shaft which runs in ball bearings carried on a suitable framing. Beaters, brushes or combs can be mounted on the drum, and the whole is enclosed in a mild steel-plate casing arranged in halves, the bottom half being provided with a large door for the extraction of the tow. The top half of the casing has an opening into which the hanks of fibre are inserted for brushing. This opening is of a special shape, which prevents the operator's hands getting inside the casing. A grid, which is removable for cleaning, is fitted in the base of the machine, and if a duct is provided in the foundations under the centre of the machine the dust caused by the brushing can be extracted by means of a fan and taken outside the building. The small extra cost involved by the provision of a dust-extraction fan will be found advantageous, as the working conditions in the dust-laden air of most sisal brushing rooms are very unpleasant, and probably account in a large measure for the difficulty often experienced in obtaining labour for working brushing machines. The capacity of this machine is 25 to 30 cwt. per day, and the power required to drive it is 3 b.h.p.

The amount of brushing required to produce No. 1 quality sisal depends to a great extent on the efficiency of the decortication. If the leaves have been cleanly



By courtesy of

Messrs. Robey & Co., Ltd.
FIG. 6.—British Brushing Machines in Yucatan.
Another View. Baling Press in the foreground.

decorticated and thoroughly washed, very little brushing will be required and the drums of the brushing machines need only be fitted with plain beaters. In this case, also, comparatively little tow will be formed. If the decortication has not been clean, however, the brushing drums may have to be fitted either with bristle brushes or combs, i.e., metal beaters with a serrated edge, and in this case a considerable quantity of tow will be obtained.

It will be seen that with a hand-fed machine the amount of brushing done can be easily regulated as found necessary to produce clean fibre, whereas with the automatic machine all the fibre receives a uniform amount. There is little or no saving in the number of men actually required for operating an automatic machine as compared with a hand-fed machine, as men are necessary for placing the hanks of fibre on the conveyor table of the automatic machine and for taking the brushed fibre away from it. Brushing with hand-fed machines is, however, often rather an unpopular occupation, as it entails a good deal of physical exertion, and the dust-laden atmosphere of the brushing room is most unpleasant to work in if a dust-extraction plant is not provided. The men employed on hand brushing are nearly always paid by piece rates, and strict supervision is necessary in the brushing room, otherwise a certain amount of partially brushed fibre will be passed out, or alternatively large quantities of long fibres are allowed by the operators to be taken into the machine with the tow. It will be seen that the only real advantage to be gained by the use of automatic brushing machines is that strict supervision is rendered unnecessary, and the labour for working them is probably more easily obtained.

It is as well to conclude this section as above because after the fibre has been obtained it is passed through the brushing machine previous to being baled, and

here one would like to say that whether Yucatan washes her fibre after decortication or not, she certainly brushes it with great care ; and reports speak of their Co-operative Society, which sees to the decortication and brushing of the fibre in bulk, as having recently obtained a battery of ten brushing machines from a well-known firm on this side. As

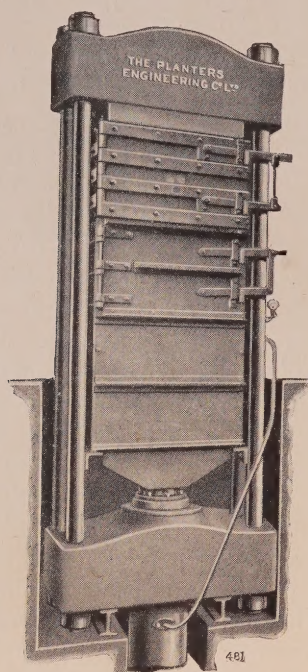


FIG. 7.—Baling Press for sisal.

Yucatan is quite unprejudiced as to where it goes for its machinery, so long as it goes to the best makers, the fact that they have erected English-made brushing machines proves what they think of those turned out in this country (see pp. 316 and 318).

The brushing being completed the fibre is ready

for baling, and to obtain some information on this operation I called on Mr. W. H. Cochrane, of The Planters Engineering Co. Ltd.

Mr. Cochrane stated that the most modern practice was to use presses exerting a considerably greater pressure than was formerly thought advisable, as it had been found that when the sisal was carefully packed no damage was done by heavy pressures, and

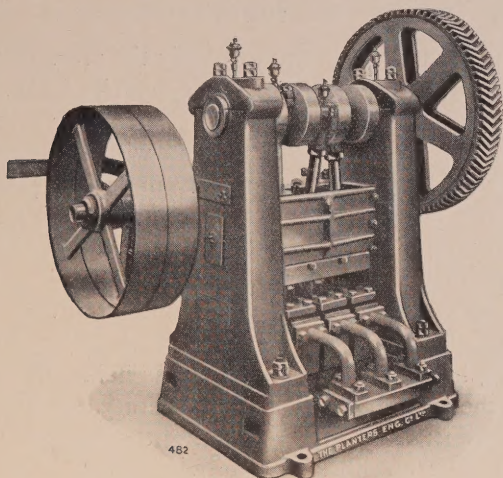


FIG. 8.—Hydraulic Press for baling sisal.

that his Company was sending out a press capable of exerting considerably over 400 tons pressure that some considered the maximum. The closer packing of the fibre was a very important item as with high freights considerable savings could be effected.

In reply to a question as to the usual weight of bales, Mr. Cochrane stated that the weights varied in different countries, and even in localities, but that he did not think the actual weight mattered so far as the ultimate purchaser was concerned, that was a matter more of local conditions, but he did consider it was a distinct advantage that all the bales from the same estate should weigh exactly the same.

The usual weight of bales was 2, 4 and 5 cwt.

For this work the Hydraulic Press has been found to give the best results. Such a press consists of the press frame, with the cylinder and ram, the box in which the fibre is packed, which should be of sufficient length to take the fibre without folding, and with the doors so arranged as to facilitate easy and rapid packing.

PUMPS.

To these add the pump to supply the pressure to the cylinder, which should be of ample capacity for the duty.

The box is usually fitted with wheels for rolling in and out of the press frame, and with this type two boxes can be installed, one being under the pressure, while the other is being packed, thus giving an increased output. Another type is to have the box fitted permanently in the press frame.

In many cases it has been found an advantage to first make up the sisal into 1 cwt. wads by preliminary pressing in a hand press. The wads being afterwards put in the main box. With this method the output of the pressing plant is further slightly increased, and weight of the fibre is perhaps more accurately measured.

MESSRS. J. ROLLAND & CO.

With regard to decortication in the areas formerly cultivated by the Germans, Mr. J. Rolland, of Messrs. J. Rolland & Co., Victoria St., S.W.1, London, reminded me that when the cultivation of sisal was being undertaken by the producers in the present East African colonies, at the beginning of the century, it was soon realized that economy could only be attained by large scale factories, whether the leaves were produced from areas owned by the factories themselves or purchased from small producers, as is done with sugar cane in the West Indies and elsewhere. However, the raw

material was obtained, the manufacturing side of the fibre on the estate had to be done on a big scale if the results were to be satisfactory. This being the case, all those interested in the industry concentrated on the production of a machine which would not only turn out fibre of an excellent quality but would also secure the maximum percentage of fibre with the minimum loss as tow or refuse. This it was found could only be secured by a machine which worked automatically, i.e., by power and not by hand, and realizing this at the time, scutching machines operated by hand were replaced, so far as was possible, by those in which the leaves were automatically conveyed to the beater or cleaning drums of the machine, and brought into contact in a suitable manner with the knives that removed the pulp from the leaves in the most speedy manner possible with the least harm to the fibre produced.

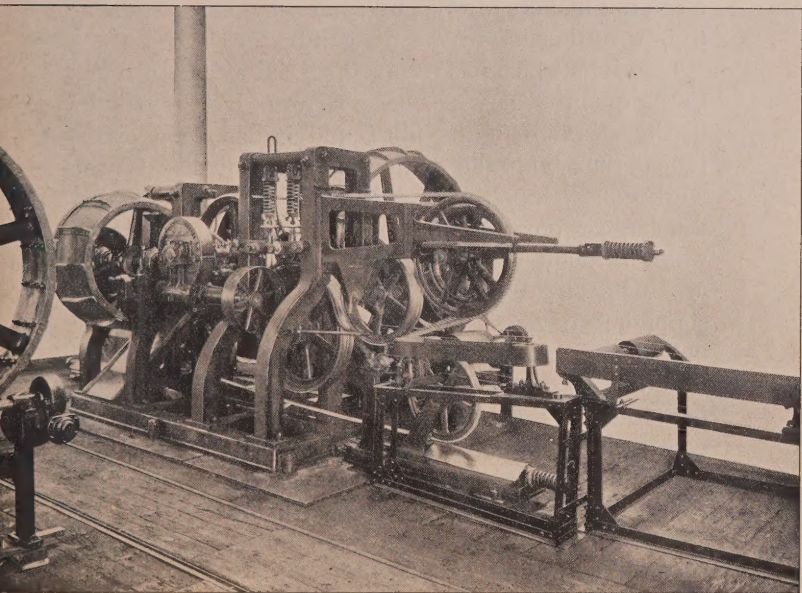
Such machines were known to already exist in Mexico, which was natural considering this was the home of the plant. These Mexican machines used chains throughout to retain the leaves in position, and at the same time to convey them through the machine, but we are told that these chains did not prove to be altogether suitable, especially as it was found they could not stand the wear and tear to a degree that did not spoil or check the work to be done, and owing to the distance of the country and of the sisal-producing areas in that country from more up-to-date centres, which produced the decorticators or the parts thereof as they wore out, considerable interruptions in the work resulted when renewals became necessary. Determined to do away with this disadvantage, trials were made of running the machine with leather bands having strips sewn lengthways on them instead of the expensive chains which had not proved satisfactory. This continued until 1908, when the happy idea was conceived of utilizing the

product of the machine itself, i.e., the sisal fibre, as the driving medium, with the result that ropes made of sisal hemp were substituted to furnish the means of conveying the leaves through the machine. This change proved quite successful, and ever since then, with the use of sisal hemp ropes in the decorticators, the serious breakdowns complained of formerly have been avoided, for even if the ropes wear out, or become otherwise unsuitable, they can always be easily replaced by new ones made on the spot and kept in stock at a small cost.

Thus Mr. Rolland argued when explaining the advantages of the Corona machine to the writer, who already knew the machine, as in the old days before the war Mr. Hubert J. Boeken, the inventor, was a not infrequent visitor at my office, knowing the interest taken on both sides with anything to do with sisal production. I quite well remember his visit when he explained how and why he had agreed with the firm of Krupps to make and market his decorticators for him. To-day it is claimed that the automatic working of this machine has reached such a degree of perfection that, wherever used, the planters have declared themselves to be entirely satisfied with the working and the buyers of the fibre equally satisfied with the quality of the shipments received by them. This certainly was the original aim of the inventor, who always claimed, as do the makers of the machines to-day, that since the leaves and the fibre must be subjected to severe treatment in order thoroughly to cleanse the latter, the fitting together of the entire machine must be gauged to a nicety, as otherwise the best results, especially with regard to the uniformity in the fibre, could not be looked for. This being so, the way in which the ropes of the No. 4 Corona machine seize hold of and move the leaves into position whilst being treated is considered

to produce the most perfectly clean fibre on the market, as well as increasing the percentage of marketable fibre out of the possible total contained in the leaves.

One listened with careful attention to what was said as to the care that must be taken to increase the lasting qualities of the metal work, which means to say the whole of the decorticating machine, for, it was pointed



By courtesy of

Messrs. Krupp, Grusonwerk.

FIG. 9.—The "Corona" No. 4 Decorticator.

out, it must be realized that the effect of the acid juice of the leaves on the metal, coupled with the heavy strain and stress upon the machine, causes very trying demands to be made on its endurance; this is not surprising when one remembers that more than 100 tons of leaves are frequently run through a single machine in the course of a shift of eight hours. This again, in its turn, renders necessary systematic observation of all the

influences that the work demanded of the machine have upon its powers to keep going on an "even keel," as otherwise any inequality in the working must tend to break the fibres as well as to strain and spoil the machines. This being the case, the facility with which the interchangeable portions of the machine can be taken out and replaced is a great asset, and furthermore the makers always welcome any suggestion as to how further improvements can be introduced.

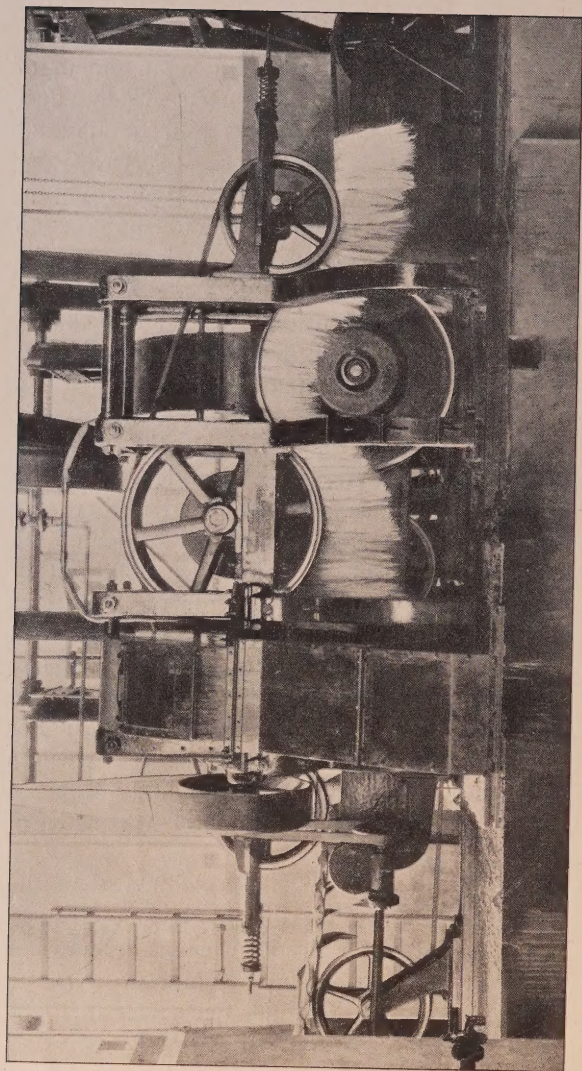
One item which has received special attention refers to the quantity of water necessary to give best results in the cleaning of the fibre, and it has been ascertained that both the output and the quality of the work done generally are greatly enhanced by passing the largest possible amount of flushing and washing water through the scutching drums whilst the leaves are being treated. To help in this, special water-supplying devices have been introduced, which not only have been found to improve the quality of the fibre but also to increase the durability of the machine by reducing the acid content of the juices of the plant, which dilution causes the liquor to exercise a less injurious effect on the metal; again, the troublesome effects on the running of earth and sand, which so often manage to creep in somehow, is considerably lessened with the larger flush of water.

Other improvements introduced in collaboration with the experience and suggestions of the actual users refer to the utilization of antifriction bearings, which greatly facilitate the output of fibre, and also the adjustment of the scutching drum with respect to the breast-piece which the leaves come up against. This brings about a degree of exactness in the distance that is, needless to say, most important to attain if the leaves are to pass smoothly along the space between the knives and the breast-plate.

Electrically operated machines, a system which is

often adopted where a suitable supply of current is available, have their driving motors accommodated on a frame well out of the reach of dirt and water. Regarding the general scheme and arrangement of the factory, there are two main aspects which affect the procedure of choosing the sites and the lay-out of the factory in different centres. In Africa, for instance, and in a few of the less extensive fibre-growing districts, there is a preference for the erection of works with one, two, or three decorticators, whilst in the Dutch East Indies the planters seem to prefer to lay down large installations or batteries of machines, up to sixteen fibre-extracting machines of the largest capacity being used by one plantation. Needless to say, much capital is required in such cases, especially as an extensive and well-equipped light railway system is needed in order to transport the leaves to the factory in the first place, and the baled fibre to the railway or shipping centre afterwards. Much of the foregoing refers equally well to the extraction of other fibres than sisal; certain adjustments or alterations may be required, but on the whole, whether with Mauritius or Manila hemp, quite satisfactory results have been obtained when working on a large scale. Since, however, there is a demand for the smaller type of machines, it may be as well to say a few words on the modern equivalent of the old Mexican Raspador machine, an illustration of which is of course to be found on p. 31.

Under certain conditions it is claimed that the smaller plantations can still be run and give good results. Since such estates do not produce leaves in sufficient quantities to justify the employment of a large machine like the No. 4 Corona, decorticators to be operated by hand have been designed and give every sign of showing satisfactory returns. These scutching machines operate on the same principle as the big

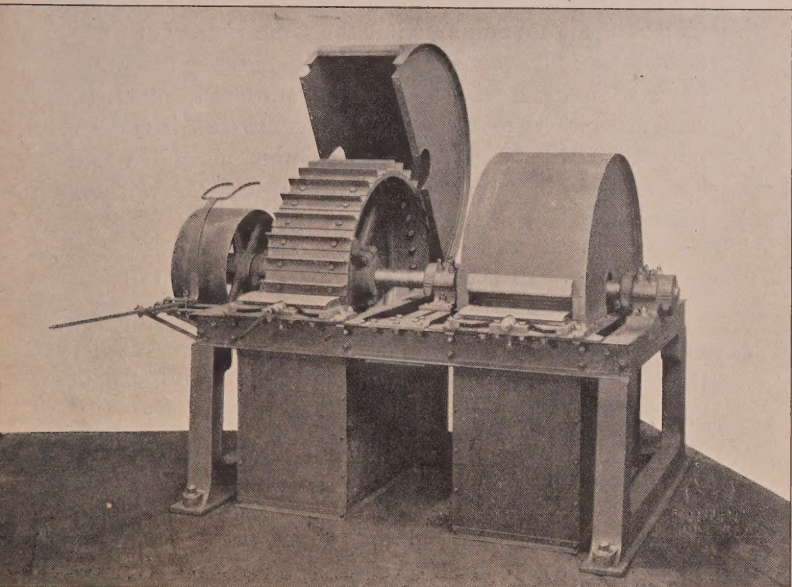


By courtesy of

FIG. 10.—The "Corona" Decorticator.
Another View.

Messrs. Krupp, Grusonwerk.

power decorticators, but they differ in several ways, as with the introduction of the leaves, which are not conveyed continuously through the machine but have to be fed in leaf by leaf lengthways by hand, between a drum fitted with beater knives and a concave thrust plate working against them. The action of these knives, in conjunction with the concave plate, results



By courtesy of

Messrs. Krupp, Grusonwerk.

FIG. 11.—A Double Raspador, as mentioned on p. 330.

in the removal of the whole of the pulp so as to leave the fibre exposed for further treatment. Such machines, however, require the leaves to be held fast, so that it follows naturally that only one half of the leaves can be scutched at a time, after which it is reversed and the other end gets cleaned in its turn. In spite of these drawbacks, when these hand machines are skilfully handled by those who have had con-

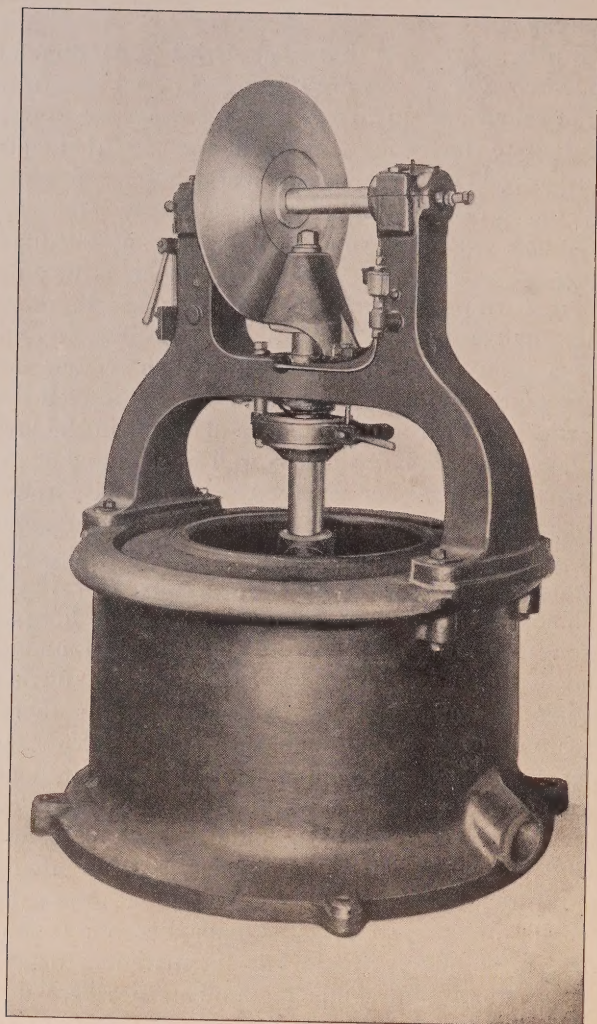
siderable practice at the work, good results are obtained both in the quality of the fibre and in the quantity of the output, with an astonishing small amount of broken fibre or tow. Should the output, however, be found too small, it can be increased by installing double scutching machines, i.e., by mounting two scutching drums with beaters upon the same shaft, and double machines of this kind, according to whether one man or a pair are employed at the same time, will clean 800 or 1,600 leaves per hour. When these machines have been described as hand operated, it must be remembered that the drums have to be driven by power, i.e., by means of belts running at high speed and encased in metal sheeting to protect the workers from harm.

DRYING,—THE ADVANTAGES OF CENTRIFUGING.

As everybody knows, the sisal hemp of commerce in these days has to be prepared with great care in order that it may present a white, apparently polished appearance when placed upon the market for sale; without making any reflection upon the strength of the fibre whether of pleasing exterior or not, it is always just as well to offer attractive goods for sale instead of a raw material that looks rather grubby in appearance as though it has not been properly cleansed or prepared. Buyers and actual consumers to-day are quite competent of judging whether the fibre offered them for purchase is up to their required standard as regards strength, whilst the clean white appearance not only enables them to put up a more attractive cord or twine, but it must and does always carry the conviction to everyone's mind that the planter who is careful to finish off his goods properly is also likely to be careful in the production of them from the start. This view naturally prejudices the buyer in favour of such raw material, since it gives

him the idea that care has been bestowed upon it throughout.

Furthermore, now that East Africa generally and the Dutch East Indies are turning out sisal so attractive in colour and quality, it behoves everyone to pay attention to the means employed to ensure that such fibre is produced every time, everywhere, and especially that it can be produced independently of outdoor conditions, where, if you have to hang up the fibre during wet periods, or even when the air is heavily saturated with moisture, you cannot expect anything better than a number three fibre to result. Recent reports from the Dutch East Indies show that the course taken by the factories over there is to feed the decorticators with ample supplies of water in the first place, so that the fibre shall be well washed and every particle of refuse be removed, as otherwise these particles adhere to the fibre and become decomposed when exposed to the air, and thus cause discoloration. Originally, the idea was to use the centrifugal machines to expel the surface water from the fibre as it came from the decorticators, but latterly I understand it has been found good to introduce further supplies of water into the centrifugal drums themselves (taking care that the water is quite clean), as doing so subjects the contents to what can well be described as an intensive washing process by driving the water through and through the various fibres, and finally, the supply of water having been run off and cut off through an aperture, by continuing to run the machine, the fibre, so far as its outer condition is concerned, is thoroughly dried. I do not guarantee to have told the story quite complete in all its details, but I trust that I have said enough to attract the attention of the reader to the idea generally, for it appeals to me as being an excellent one in face of the trouble that has often been experienced by the planter to dry



By courtesy of

Messrs. Krupp, Grusonwerk.

FIG. 12.—A modern centrifugal for Drying Sisal.

his crops to a good colour amidst unfavourable weather conditions.

The centrifugal machine employed for this purpose resembles those used in the sugar refineries, and therefore in some cases it might come about that in Cuba, Java and other centres, should both sugar and sisal be produced fairly close together, the same battery and the same power driving that battery might to a certain degree be utilized for both crops, but of this I am not too certain, since when using the centrifugal for sisal it has to be made of materials which can withstand the corroding action of the vegetable acids, and to do this they are lined where necessary with rubber or copper, or lead, if not with other materials. In the matter of the general arrangement of the machines there are, in the main, two types, both of which discharge at the top. One type is known as the Pendulum centrifugal or centrifuge, as used in many branches of industry; here, the revolving cage is suspended in pendulum fashion so as to cause small discrepancies, for want of a better term on the spur of the moment, in the alignment of the fibres which enable them to adjust themselves automatically. Considerable skill is required, it seems, properly to pack in the wet fibres, which must be done fairly evenly if good results are to be obtained, but constant practice apparently soon enables the natives to attain proficiency and accuracy in this portion of the work, and also in watching the machine, which must be done carefully when starting in order to avoid obstruction and consequent damage which is liable to arise. Users of the old type of centrifugal claim that it gives less trouble owing to the fact that its revolving axis rests in fixed bearings, and therefore offers a machine that can stand rougher usage than the pendulum type, which, if somewhat cheaper in the first place, requires rather better understanding and

more careful handling. On the whole, however, with the tendency for native labour to become better trained, it rather looks as if the pendulum type will win through as a rule. Mr. Rolland, to whom I am indebted for much of this information, tells me that his principals supply either type of centrifugal, and that it is generally considered that one machine should be able to handle the output of one Corona decorticator. To this he added, "We have always been able to give satisfaction to our friends in the Dutch East Indies in the design and construction of these machines, which is not surprising, as we pay the utmost attention to the safety of the natives who have to work them and also to the safety of the machines to be worked by protecting the metal as much as possible from the corroding action of the acid juices."

DRYING.—THE SCHILDE PROCESS.

Since Dr. Mann and Major Boyd drew up their reports at the beginning of the century on the production and preparation of sisal for market, it is probable that the still somewhat impracticable ideals as to what can be used to advantage for the drying of fibre, has undergone a greater change in the actual methods employed than any other section of the sisal industry, or for that matter of any other industry.

Since during the last ten or twenty years, the production of sisal has tended to be run on a large scale as regards the output from individual estates, it is not at all surprising that the industry on the whole has discontinued using machinery and appliances of small dimensions and gone in for larger plants on a parity with the larger areas and the larger outputs now being dealt with, and those who are certainly not novices at the work will tell you that nothing will aid or encourage the production of sisal on a large

scale more than improved and quicker methods of drying the fibre.

Already those who pride themselves on being up to date in the matter are inclined to talk with an amused expression on their faces of the hanging of the fibre out in the open after being washed, and trusting to the wind and sun to do the work for them even if there were neither wind nor sun in evidence. They will remind you of the large amount of work involved in laying out the extensive fibre-drying areas with frames and wires, or, in the case of thrifty men, with the sisal poles themselves, over which were slung the masses of sisal as taken from the decorticators. These masses, many times their own weight with added water, had to be brought out into the open, swung up on the wires or poles, and even when there, had to be constantly turned and finally gathered together again by a large number of workmen who could have been, and should have been, far more profitably employed elsewhere. It was not only the ordinary workman whose time was taken up in this way ; experienced hands had to supervise and see that the fibre was turned at the right moment and not taken down and hurried off to be baled before it was thoroughly dry by those who, out of impatience or through being pressed to hurry, had grown tired of seeing it on the cross-bars for days on end when the weather seemed inclined to do everything else but to help in the operations. Thus it was that both men and fibre have suffered and are still suffering to a great degree through unsuitable and ever changing weather conditions which, when the drying is carried out in the open, must cost the planter much money for extra labour bills, and lose him much money for inferior fibre in which the colour and general appearance have suffered from being exposed to the winds and weather as well as on account of the dirt that is always to be met with in the drying fields.

Compare all this with the modern appliances, where the work is carried out very much as follows: the leaves are brought to the factory from the fields on the light railway trolleys drawn by the engines that everybody sees nowadays on well-managed estates. With a little management and practice, these trolleys, or rather their contents, can be passed through into the building at much the same rate as they can be brought up from the fields, and so they can all be passed through the decorticators and treated the same day, after which they are washed not only whilst being decorticated, but also according to the latest ideas,



FIG. 13.—Sisal Drying. The old way.

whilst in the centrifuges themselves. The centrifuges are started up and the water is played on to the fibre in it for a couple of minutes, after which the water supply is turned off and the centrifuges allowed to run for about a quarter of an hour until all the excess moisture has been removed, the water as it runs off through the fibre taking with it the last remnants of pulp, &c., still adhering to the fibre when it comes from the decorticator. Whilst in the centrifuge the fibre does not of course become entangled at all, and is then simply picked out an armful at a time and passed

to the dryer for finally drying out, either direct or by some convenient arrangement of conveyor bands.

The well-known "Schilde" Patent Band Dryer is now being used almost entirely in the Dutch East Indies, and to some extent elsewhere to finish off the work in the way described. The "Schilde" machines to artificially dry sisal fibre were first introduced into the Dutch East Indies about 1912, and since then the number at work has rapidly, Mr. Rolland tells us, increased until practically all the large sisal plantations there have such machines at work.

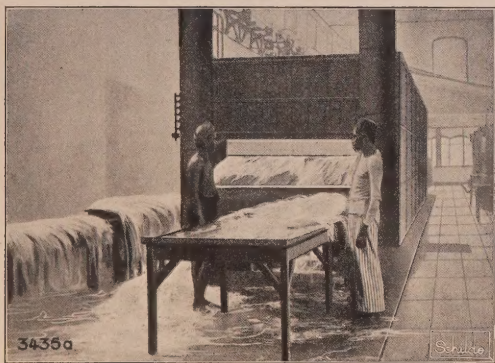


FIG. 14.—Sisal Drying. The new way by the Schilde System.

The makers of these machines claim that they are proving so useful and successful that the orders for the apparatus tend to increase at a very satisfactory rate. This is due to the fact that the whole process is carried on continuously and in such a way that the handling of the material to be dried is reduced to a minimum in marked contrast to the large staff of workers that had hitherto been necessary when drying the fibre out of doors. One can easily realize what takes place: the fibre, still considerably moist as it comes from the centrifuges, is laid on the continuously

moving transport band at the feed end of the Dryer and is carried the entire length of the drying channel until it emerges at the discharge end quite dry and of an excellent colour and cleanliness. The very full details I am not competent to give, but can say the drying is carried out according to what is known as the "Stepped Air Circulation Drying Process" with the help of Patented Air Circulation Cell Series Blowers. These blowers are of special construction and have been patented in nearly every country in the world by the makers, viz., Messrs. Benno Schilde Maschinenbau, A. G. Hersfeld, H.N. As their name implies the blowers consist of a number of fans each arranged in a separate cell and mounted in series on a common shaft. Arranged in conjunction with the blowers are heating batteries, the air being heated in its passage through these before being blown on to the fibre. The machine is divided into a number of sections or zones, and as the drying air passes slowly along the length of the drying chamber, it is warmed step by step as it passes from one field to the next; hence the term "Stepped Air Circulation Drying." It is particularly worthy of mention here that this system of drying requires a very small amount of steam as by the drying method above described each zone acts as a pre-heater for the next. The machine is fitted if required with cooling and conditioning zones through which the fibre passes after it has been dried, the fibre finally passing to the Sorting Room where it is brushed and baled. It will then be found to be appreciably white and more attractive looking than when dried in the open air, and it is for this reason that the Schilde Dryer has become so popular on the larger and largest sisal estates. On some of them of course several machines are at work and good results have been obtained in every case, whilst the total daily output of the "Schildes" Sisal Dryers so

far supplied runs into several thousands of tons in the aggregate.

THE BRUSHING OF SISAL.

Having discussed the only certain means of obtaining a perfectly clean fibre from the decorticator, viz., by using plenty of water, and having properly dried it, we will next pass on to the brushing machine now generally adopted, since, according to published reports, even Mexico has imported a battery of these necessary appliances for improving the appearance of their henequen. They are quite right to do so, as it is said that at times the foreign matter which adheres to their fibre, when it is thoroughly dry causes about 10 per cent. loss in weight owing to the refuse, now turned into dust, which has been purchased with the bale of fibre. Apart from the loss to the buyer, or to the seller if the buyer reduced his bid on account of the dust, its presence interferes seriously with the way in which the sisal can be handled in the rope or twine factory, as well as adding to the cost of transport to a totally unnecessary extent.

This being the case, the modern brushing machine has been designed not only to put the fibres in their place, but also to free them from every particle of dust possible, as well as from the few broken fibres which even the best modern machine turns out, but which must not be included in the bale. Skilled hands at brushing sisal claim that they can, to a very considerable extent, turn out brushed fibre far more evenly as regards the bundles than can ever be looked for from the fibre as taken from the lines without brushing. If this is so, certainly it is a great advantage, for next to the presence of dirt, nothing mars a sample so much as to see uneven bundles laying on the counter in the samples submitted to the buyers; the latter also cannot be an advantage to

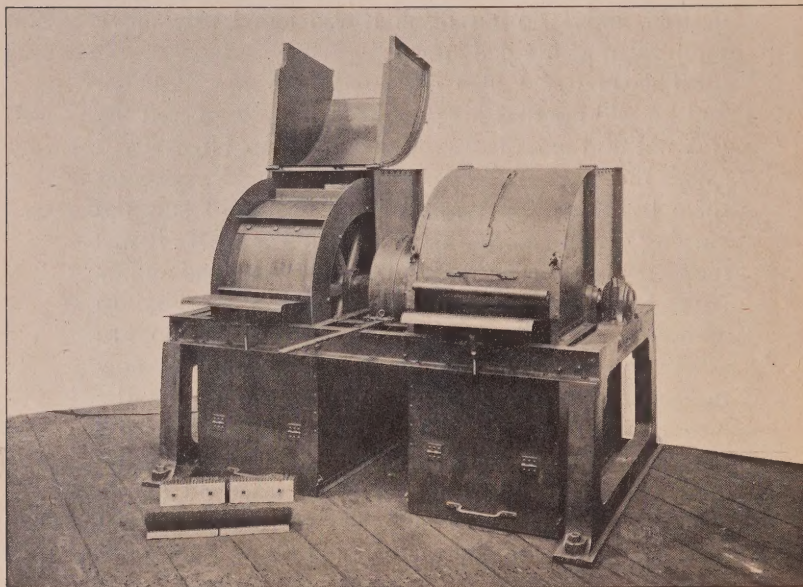
the spinner in the factory, otherwise they would not be so anxious to avoid parcels submitted for purchase which show the presence of dust and uneven fibre.

The story of the evolution of the, at present, perfect brushing machine compared with those in the past is very interesting. The original machines seem to have been so constructed as to treat the fibre after being dried by feeding it in by hand between what can be described as a serving board and a revolving drum furnished with a number of brushes containing more or less hard bristles. This serving board, which generally was made of sheet metal, kept the fibre in place and generally supported it whilst it was being brushed, but it required considerable skill on the part of the worker to "play" with the fibre, i.e., to push it in here, and pull it out there, in order that the brushes could act upon the whole of that which had to be worked. True that this machine turned out fibre free from dust and almost free from tangled fibres, whilst it also gave the contents a certain amount of gloss owing to the polishing effect arising through the friction applied by the brushes. The drawback to this machine seemed to be the ability of the brushes to withdraw individual strands from out of the bundles and tangle them up so that not only was there an unnecessary amount of waste, some of which tended to clog the brushes, but also that these few tangled fibres were inclined to get into the bulk and spoil the samples. Furthermore, as the main pressure came on the centre of the brushes, they showed considerable wear in portions only of the brush, and so caused the rest of an expensive item in the machine to be wasted. To avoid this, brass and steel wires were introduced, but little if any advantage was obtained, whilst the wires were inclined to break and the broken metal points became a source of injury to the operators, and were a nuisance all

round. Other devices were made use of but gave no better results, if as good, whilst it began to be realized that the heckling machines used in the flax industry, which are provided with wooden arms attached to a revolving shaft to act upon the flax, might be adapted for use for sisal as well. So far as I know, however, although such a process removed the dust, it did not seem to affect the fibre in the way desired, and I do not think it was found to remove the broken or tangled strands.

This matter I also discussed with Mr. Rölland, and he told me that his principals had discovered the way out of the difficulty in the first place by putting aside the use of brushes altogether and replacing them by beater ledges, a form of beater to suit the varying conditions of the various fibres where it was found that differences existed. Much time and money have been expended in adapting the machine to modern requirements, until to-day those who are making use of them are the best judges to say how the makers have succeeded in turning out what the planters require. The latest brushing machine from the Gruson Works has these beater ledges in the form of angle iron with one flange attached to the drum, whilst the other ledge has teeth of a special form cut in it. In this way the fibres are thoroughly cleaned, unravelled and adequately polished, and if there are those who would claim that this beater form did not polish the fibre to the same extent as was obtained from the brushes, so long as the fibre is attractive and causes no comments from the buyers, such a system does away with many of the disadvantages of brushes, and certainly the majority of those who have used this new machine have expressed approval of it. I understand that the arrangement made to avoid any chance of the fibre being caught up in and consequently clogging the

machine is avoided, whilst it is also claimed that provision is made to avoid the bearings becoming heated owing to detached fibres becoming twisted round them, as can easily happen if provision is not made to avoid such a thing, which can in extreme cases prove very serious owing to the inflammable nature of the fibre. From the native workers' point of view,



By courtesy of

Messrs. Krupp, Grusonwerk.

FIG. 15.—A modern Brushing Machine, showing one side open.

advantages are claimed in the manner in which they are protected from annoyance by dust. This annoyance should not be, as the dust can easily be conveyed to a chamber or dust-absorbing conduit, from which it can be removed to wheresoever it should go by means of fans; all such advantages, together with any other improvement suggested by the buyers,

can be and will be supplied with pleasure by Messrs. J. Rolland & Co., on receipt of full particulars.

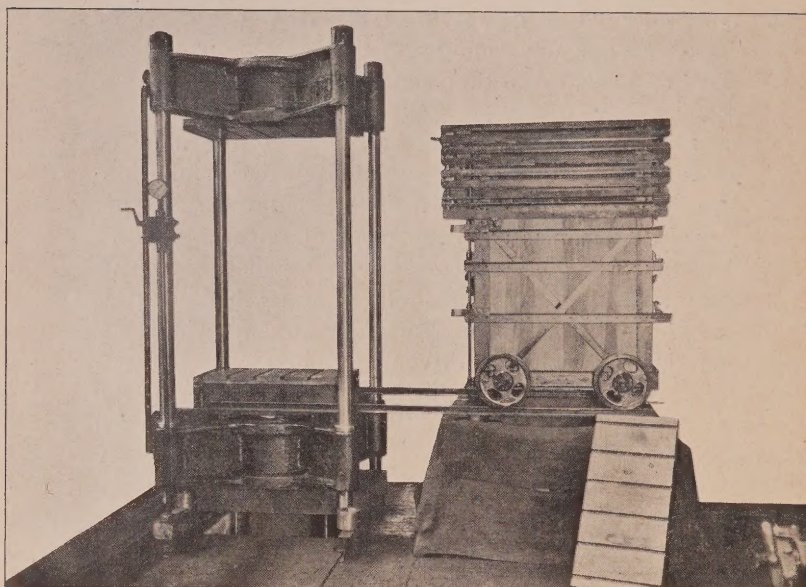
BALING THE FIBRE.

As sisal has to be transported by land and sea, as a rule for considerable distances, before it can be used by the final purchaser, a system of packing or baling that is both close and careful is necessary; for whilst the fibre as it comes from the drying ground or brushing machine requires to be very closely packed, care must be taken that the pressure is not overdone or else harm can come to the contents of the bale.

Everyone who has any knowledge of the industry is well aware that the hemp is packed carefully into the baling box, where it is pressed down to the required dimensions by means of an upper and lower platen, the requisite pressure being applied in various ways, as by a screw spindle or a toothed rack or toggle-joint lever, which are operated by single or multiple appliances driven by hand or power. Hydraulic presses are preferred in all cases where the uttermost pressure is required, and are naturally used on the bulk of estates. The hydraulic presses made by the Gruson works of Messrs. Fried. Krupp are designed for the peculiar requirements of the sisal or fibre industry generally. Formerly a pressure of 100, or at the most 150 tons, was considered sufficient, but to-day there is a demand for a far more powerful press, it having been found that with modern improvements the cubic measurements can be further reduced without harm to the fibre, whilst a saving in the freight is effected. This being the case the latest Gruson type of press has a total pressure of 300 tons, and orders have been executed where the 300-ton-press has been reinforced or strengthened so as to be able to withstand the pressure of 400 tons in all.

A complete baling outfit therefore may be said to

comprise : (1) The hydraulic press itself ; (2) one or more baling boxes running on wheels to receive the fibre ; (3) a compound pressure pump unit ; (4) the valve control ; and (5) the requisite piping to supply the pressure. With regard to the presses, an upper and lower platen or press head of cast steel, together with the four steel columns connecting these heads,



By courtesy of

Messrs. Krupp, Grusonwerk.

FIG. 16.—The Baling Press described above.

can be said to form the frame of the press. The lower press head accommodates the pressure cylinder, which is made of a metal specially adapted to withstand high fluid pressure. The press plunger which carries the platen is made of a specially hard cast steel and is finely polished. The baling box is capable of taking up to about 5 cwt. of fibre ; the bottom of it

is closed by a loose plate furnished with grid openings, through which the hoop-iron or other binding material is passed ready for when the bale is to be bound whilst still in the press. At the top the box is heavily reinforced with steel rails to enable it to withstand the very high pressure to which it is subjected. The boxes are made 52 and 60 in. long to suit the length of fibre to be packed. Care should be taken that the length is sufficient, so as to avoid kinks and fractures of the fibre whilst under pressure. The canvas covering required to keep the fibre clean whilst being transported can easily be sewn or otherwise fastened whilst the bale is still in the press.

Coming to details as to the working of the presses, the water or other fluid required is fed by means of a multiple pump provided with special devices, which cause the individual pumps to be "cut out" as the pressure rises above the danger point; in any case a safety-valve obviates the maximum pressure being exceeded. The pressure fluid may be water, provided it is free from impurities, but experienced men claim that it is best to use a freely-flowing liquid oil, whilst an emulsion prepared with water has likewise proved satisfactory, more especially as it seems to help lengthen the life of the leather-cup packings. This will be all the more noticeable in face of the fact that as time goes by the heavier pressure machines seem likely to be most in demand.

Discussing the best means for getting rid of the moisture from sisal with Messrs. Thomas Broadbent and Sons, Ltd., Huddersfield, they supported the claims advanced for centrifugals for the following reasons among others:—

(1) A batch of material can be de-watered within six to eight minutes.

(2) Every batch of material can be relied upon to be dried uniformly without variation.

(3) A centrifugal machine only occupies a few square feet of floor space.

(4) A centrifugal machine can be worked by unskilled labour, and requires very little maintenance.

(5) These machines can be put down in any convenient place and worked by hand power, belt from a line shaft, steam or oil-engine, electric motor, hydraulic, &c.

They can be equipped with mixing tanks and steaming or washing arrangements, discharge hoppers, &c.

(6) Centrifugal drying is both cheaper and quicker than any form of air drying, and a machine very soon pays for itself in labour costs alone.

(7) The effluent can be collected in a receiving vessel if it has any commercial value.

THE BLACKMAN EXPORT CO., LTD.

Discussing the use of centrifugal machines—first for washing the fibre, sisal or otherwise, and then having turned off the water for drying the contents of the centrifugal—with the Blackman Export Co., Ltd., London, in order to see how such a method would affect the demand for fans, they told me that they had heard of quite a number of inquiries for such appliances from sisal planters and they agree that their use on those estates was on the increase. To what degree such a system for drying will cut out the old-time method of pole or line-drying in the open remains to be seen, because of course there is the question of cost and of driving the centrifugal, whilst on the other hand there is a great saving in the labour bill for putting up the drenchingly wet fibre and then taking it in when dry, and always the risk of having the entire output spoilt by adverse weather conditions. To-day sisal planters as a whole seem to be weighing

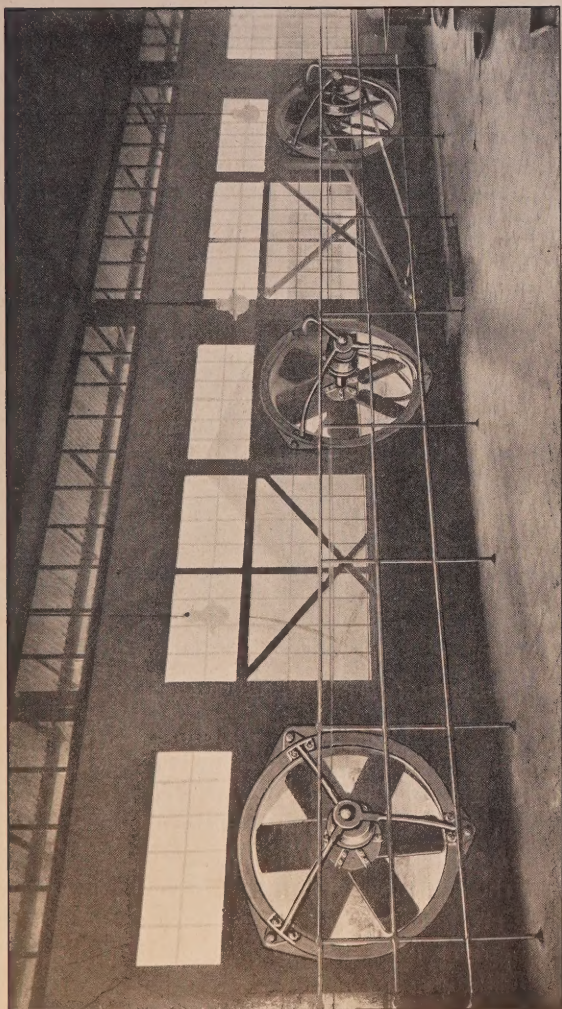


FIG. 17.—Set of three Blackman Streamline Fans for drying or dust removal, as also used extensively on tea estates.

the pros and cons of open-air versus indoor drying, and it seems likely that if they decide on the latter they will certainly make some use of centrifugals and then use band-drying through a heated room provided with fans or some similar process for preparing the fibre for baling.

Mr. Copping, of the Blackman Company, has not, so far, been entirely converted to the use of centrifugals as being the modern ideal for sisal-drying. "We advocate," he told me, "a system that shall be as near the natural one as possible, and our method is to create Nature's drying conditions, viz., plenty of air in the shape of a gentle breeze below its saturation point, so that it has the capacity to absorb further moisture. This we do by using large Blackman Streamline Fans (Propeller) which draw large volumes of air through travelling bands on which the straight untangled fibre is carried."

The fans and bands are, of course, under cover, so that they are protected from rain but open to the assistance of the sun's rays.

MESSRS. SHIRTLIFF BROS., LTD.

BRUSHING, BALING, BRIQUETTING.

Perhaps, when one reads the foregoing, enough emphasis has not been laid upon the fact that besides the 85 per cent. of moisture or water contained in the refuse from the sisal leaves after decortication, at least four or five times that volume of water will be present owing to the added water introduced whilst the leaves and fibre are going through the machine. All this, of course, gives a very large quantity of liquid on a large estate to be handled, whether or no it is proposed to separate the fibre and solids from the liquor and turn a portion of the latter into alcohol. Whatever it is proposed finally to do with the residue,

this proportion of water to solid must be borne in mind, and it would be perhaps as well on estates where water is not over-abundant if the liquor were run off into settling tanks from which the clean water, perhaps running through some form of filter or otherwise treated, could be utilized again for washing a subsequent lot of fibre; experts, however, say not.

Regarding the brushing of sisal or henequen fibre, Mr. Frederick Shirtliff, of Letchworth, Hertfordshire, who specializes in these brushing machines, tells me that the best way of finishing off your fibre previous to baling it is to brush it well.

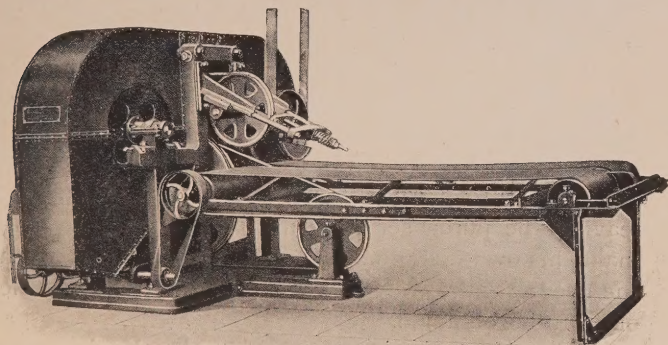


FIG. 18.—The Shirtliff Double Brushing Machine.
(Feeding-in end.)

Although the modern decorticator cleans the fibre very well, there is always a small quantity of dried pulp and dust left on the fibre. If this is not removed before it reaches the spinner, he says nasty things about it, and if he can buy the fibre he wants without this dust and pulp he will certainly do so, even if he has to pay a little more for it.

This has led to the introduction of the brushing machine, which gets rid of the objectionable dust

and dried pulp, and in the process burnishes and brightens the fibre, as well as straightens it. In fact, well brushed sisal has a real lustre making you think of silk.

The demand for such fibre is comparatively recent, but there is no doubt it has come to stay, and the day is not far distant when every producer will have to brush his fibre before he markets it.

The machines for this work are all practically on the same principle, consisting of a drum carrying a number of brushes and beaters of varying kinds, on the periphery, revolving at a fair speed, against which the sisal is presented and thereby beaten, brushed, combed and agitated generally until all the dust, &c., has been removed.

"In the case of some growers, on grounds of economy in first cost," Mr. Shirtliff added, "we supply just the essential parts of a proper brushing machine. That is, one or two drums, with the requisite brushes, &c., the shaft, bearings, and pulleys, leaving the purchaser to fit up his own framing and make his own dust guards, &c., for which we furnish the necessary drawings. That is the cheapest possible outfit to be obtained.

"For those who can go in for a better plant, we supply complete machines with one or two drums as generally illustrated in figures 18 and 19, and when there is plenty of labour available these machines are very useful. There is one drawback to them, however, viz., that the quality of the output is entirely dependent upon the labour and supervision. This is inherent, of course, in all hand-operated machines. If this labour is good the results are good, but if not then it is money thrown away to pretend to brush at all.

"To get over these labour troubles we make an entirely automatic brusher, so that all the labour has to do is to bring the fibre to the machine, place it on the feed table, and then take it away from the other

side, where it is put automatically by the machine after it has been brushed.

Here is a second view (fig. 19) of the same machine from another point of view.

“Incidentally, we may say that this machine is the most economical proposition of the lot, as, for a given output of, say, three tons per day, the initial cost of one of these machines is less than the cost of an

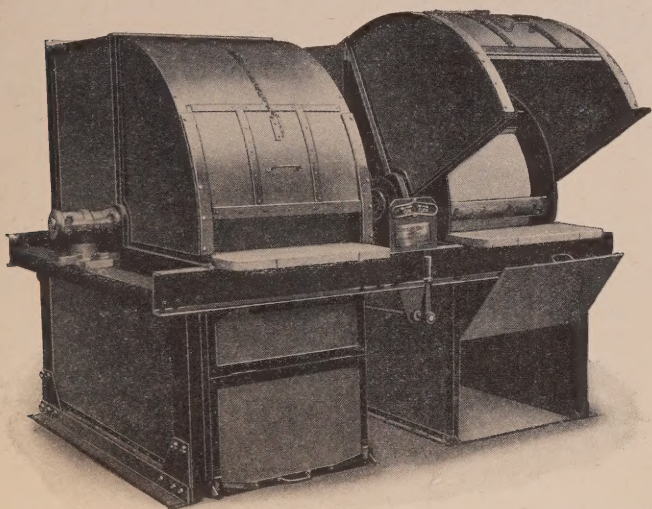


FIG. 19.—Double Brushing Machine.
(Delivery end.)

equivalent battery of hand-fed brushing machines. Also the labour cost is less.

“With the introduction of brushing machines the troubles of the sisal producer have not come to an end by any means, but rather the other way, as owing to the uncanny and most unpleasant way this fibre has of wrapping round anything revolving, the early machines were as often stopped for clearing as they were for working.

"This was most earnestly considered by us, and after much experimenting we have evolved a machine that will run all day long without having to be stopped at all for cleaning and clearing shafts and other working parts. The details of these machines are, if anything, more important than the general design, and to these we have given great thought and study.

"The actual cleaning of the fibre is done by beaters and brushes, and the diversity of opinion in regard to their respective merits is considerable. Some users advocate the use of brushes only, others say beaters only, whilst others again ask for both, and we think the last ones are right.

"Then, again, should the beaters be of metal or wood? Should the 'business' edge of them be smooth or serrated like a saw blade? All of one kind or some of each? With regard to the brushes, when used, should they have long soft bristles or short stiff ones?

"All these points are extremely important, and the process of brushing is really worth much more attention than it generally gets. You want to eliminate all dust and dried pulp from the fibre, burnish it well and straighten it nicely, and do all this with the minimum of tow.

"This latter is the great bugbear of brushing, and nothing conduces to it more than brushing machines having brushes with short stiff bristles; this naturally causes some users to vote against brushes made of them.

"After brushing comes the baling of the fibre for shipment, and those of the mechanical type are really the most suitable, and," claims Mr. Shirliff, "my firm having specialized in these for many years, has brought them to a very high state of efficiency by now.

"Sisal is put up in bales of various weights and sizes from about $\frac{1}{2}$ cwt. each to about half a ton, but

the generally popular weight is 4 cwt. or 5 cwt. The density of the bales also varies a lot from about 140 cubic ft. per ton down to something between 50 to 60 cubic ft. per ton. The denser the bales, of course, the less freight there is to pay, but if the fibre is packed too tightly it is quite possible to damage it, and the limit seems to be round about 60 cubic ft. per ton, although a greater density is being called for.

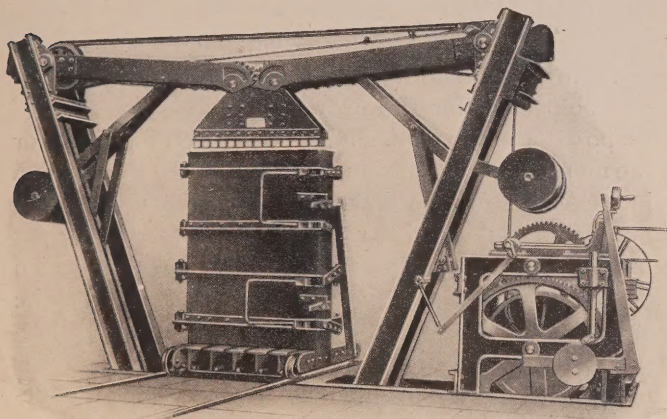


FIG. 20.—The "Bijoli" Baling Press.

"Having baled your fibre and got it all ready for despatch, let us now return to the settling tanks, or wherever the refuse from the decorticating machines has been dumped down and see what can be done with it to the best advantage of the owner of the property. Supposing it was run off straight from the decorticator, could this not be sent straight into a dehydrating filter, which would separate the solid from the liquid? The latter might, even if you wish to use it again for washing a fresh lot of fibre, be allowed to settle in tanks, so that the sludge and pulp, if still

acid, would have a chance to settle at the bottom, and thus facilitate the use of the practically clean water for washing purposes. Of the solids remaining after passing the dehydrator, there is, I am told, a somewhat expensive machine used in Mexico (where it is made) that will remove the tow or short fibre from the refuse; the latter, as stated on several occasions in the book, can be returned to the land as a fertilizer, or be pressed into cakes, i.e., briquetted, and used as fuel. This, I imagine, could be done without losing the potash content when applying the ashes to the soil to help replenish the plant food that will be needed for the growing crop. Whether it is proposed to utilize the sludge in the settling tank, or the more solid refuse from the dehydrator, the residue in either case would have to be pressed in order to get rid of as much water as possible before being put into the briquetting machine. This machine, which costs about £600, is very easy to work, and quite suitable for the native labour at any of the fibre-producing centres discussed in this book.

“The pressed sludge that comes out of the dehydrater would still contain about 50 per cent. of water, and from this sludge the short fibre should be separated, as it has a ready sale. In Mexico this tow has been, so far, all separated by hand, but a machine was recently introduced which does it mechanically, and the samples of the resultant short fibre shown to us, after having been separated by the machine, were quite good.

“The final residue can now be returned to the land as a fertilizer, or it can be dried sufficiently to be briquetted and used as fuel in the plantation locomotives or under the factory boilers and the ash still utilized.” By briquetting the waste solids out of fibre refuse, a troublesome rubbish heap is not only avoided, but, by being turned into handy-sized fuel

pellets or blocks, heavy fuel bills are saved to the owners.

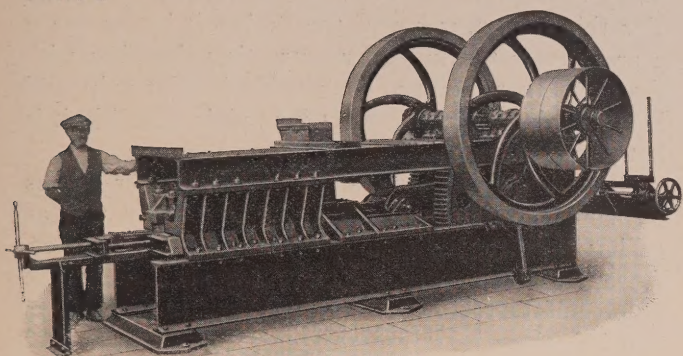


FIG. 21.—The "Bijoli" Briquetting Machine.

BLEACHING v. BRUSHING IN THE PHILIPPINES.

Concerning what has just been said about the advantages of brushing, and through that, of polishing the fibre, an article which has just appeared in the *Philippine Agricultural Review* (vol. xxii, No. 1, 1929) may be of use. It has been written by Mrs. Hartley Embrey Sherman, Chemist, Bureau of Agriculture, who has apparently been working on the improvement of Philippine abaca or manila fibre by bleaching and other methods.

Almost all the abaca of the Philippine Islands, we are told, is extracted by hand by pulling a strip of the leaf under a knife held to a block of wood by pressure. As there has been much discussion as to whether serrated edges to the scraping surfaces are better than the smooth ones, the statement which follows the above is particularly deserving of note, for we are told that when the blade of the knife is smooth a finer quality of abaca, i.e., manila hemp, is produced, but the labour, which is always arduous,

(and which we have understood in the past is very likely to rupture the workers) is further increased. For this reason, many of the native strippers use a coarsely serrated knife for extracting the fibre with the result that the fibre has much adherent pulp, and is of a dark colour, or, to put it in plain English, it is not properly cleaned.

This being the case, and since the better grades of manila fibre bring a much higher price as well as selling more readily as a rule than the coarser ones, exporters and importers have often asked how the pulp could be removed from the lower grades of fibre and its colour improved without seriously damaging its tensile strength. Quoting Mrs. Sherman verbatim, she then tells us the following story:—

“Many of the common bleaching preparations left the fibre streaked or of a dirty brown colour, often harsh in texture and very often of greatly lowered tensile strength. After many weeks of repeated trials of various concentrations, and of different combinations of many chemicals, we, i.e., Dr. Sherman and myself, finally lit upon two methods which gave splendid success in regard to the colour, appearance and texture of the bleached fibre, in fact, when we tested the change of tensile strength after bleaching by the second of our two methods, much to our surprise we found a gain of tensile strength of from 5 to 8 per cent. Careful investigation of our figures showed that the apparent gain of tensile strength was due to the fact that during the process of bleaching some of the adherent pulp, which is always present in low-grade fibres, was removed.”

Full details are given of the methods adopted and used for bleaching the fibre in the two ways already referred to, but as they cover nearly three pages of closely printed matter in the *Review*, they cannot be reproduced here. I only mention the matter in this

part of the book in order to call attention to the fact that smooth-edged scrapers, whilst being harder to work, produce the cleanest fibre, at any rate the cleanest manila or abaca fibre.

TRANSPORT.

The question of transport on a sisal estate is an essentially important subject to the economical production of the crop and is in itself a specialized form of railway engineering, which can only be learnt by long experience and close study of the varying requirements and local conditions. I, therefore, discussed the question with Mr. Francis Theakston, of Francis Theakston, Ltd., manufacturers of light railway equipment, of 60, Tufton Street, Westminster, S.W. 1 (whose works are at Crewe), knowing that this firm has equipped a large proportion of the sisal estates in Kenya, Tanganyika, West Indies, Ceylon and West Africa, &c.

The discussion brought forth the following information, which is certain to prove of great interest to those making detailed inquiries on the subject of sisal. Let us start by emphasizing that the essential bases which have to be taken into account in formulating requirements, are:—

(1) The tonnage of leaves to be delivered to the factory per day.

(2) The average distance these leaves have to be carried to the factory.

(3) The characteristics of the proposed lay-out of the line—i.e., gradients and curves, &c.

From these data will be dependent the weight of rail to be used and the most economical size of truck and method of haulage.

If the tonnage of leaves can be handled by manual or animal haulage, there will be no necessity for the use of a rail weighing more than, say, 14 lb. per

yard—with trucks of 2 tons capacity. This is the type of equipment best suited for a sisal estate in course of early development, with the cutting areas close round the factory. Later, when the cutting area is extended, heavier equipment could be substituted and the original light equipment utilized as portable or feeder lines for the main tracks.

For an estate which is already established, and the cutting area is either widely spread or at a distance from the factory, the heavier equipment would be the more economical. In this case locomotive or tractor haulage would be necessary, with trucks of 3, 4 or 5 tons capacity, and rails weighing 20 lb. or 24 lb. per yard.

It is very seldom that wooden sleepers can be economically used in sisal areas and the general practice is to employ steel ones, so that in figuring costs these should be taken into account.

To give an idea of the comparative costs of track equipment, the following figures could be taken as an approximate guide :—

- (A) *Light Track* for animal or manual traffic over rails weighing 14 lb. per yard, with steel sleepers in the section weighing 7 lb. per yard, for 2 ft. gauge. Approximate weight per mile of track—28 tons.

Cost per mile of Track, delivered
F.O.B. U.K. Port... ... £225

- (B) *Medium Track* for light locomotive or tractor traffic, in rails weighing 20 lb. per yard, with steel sleepers in section weighing 11 lb. per yard, for 2 ft. gauge. Approximate weight per mile of track—42 tons.

Cost per mile of Track, F.O.B.
U.K. Port ... £335

- (C) *Heavy Track* for locomotive traffic up to 4 ton axle-loads, in rails weighing 24 lb. per yard, with sleepers in section weighing 18 lb. per yard, for 2 ft. gauge. Approximate weight per mile of track—52 tons.

Cost per mile of Track, F.O.B.
U.K. Port ... £430

The cost delivered c.i.f. port of destination can

be assessed by taking the cost of freight and insurance on the weights given above at the ruling rates—which, for instance, for Mombasa or Dar es Salaam comes out at somewhat under £2 per ton.

It is difficult to give an indication of cost of laying this track on site, as this varies considerably according to local conditions and nature of ground ; but in most cases it should be possible to prepare ordinary average ground and lay the track for a figure, including labour costs, of about one third of the cost of the track itself. This is merely a guide, as on difficult country the cost might be appreciably more and, on the other hand, on easy country it might be usefully less. This should not be taken as an additional cost of light railway equipment, as it would cost at least as much, if not more, to make a serviceable road or track for wheeled traffic if a railway should not be laid down or if it were ever moved.

The types and sizes of sisal trucks for carrying the leaf vary accordingly, from the 1-ton capacity truck, costing about £10, to the 4 or 5-ton capacity truck, costing anything from £20 to £30 each. The simplest and cheapest form is the flat platform truck, with sockets along the sides for taking locally-made wooden stanchions, and from these the more elaborate type with steel basket-shaped bodies have developed. These bodies are generally made of steel sections in the form of a U-shape, cross connected to make a structure with fixed ends and open sides for cross loading of the leaf, or with fixed sides and open ends for longitudinal loading. Such trucks can be provided with holding-down chains to increase the holding capacity, with brakes, spring axle-boxes and buffers as required.

Tractors for petrol or paraffin fuel, or with Diesel engines, and steam locomotives for burning coal, wood or oil, cost anything from about £250 for the

smallest type up to £1,000 or so for the larger types.

A few other items, such as points and crossings, turnouts or turntables, might be necessary to complete the track layout; but the cost of these is comparatively negligible.

The refuse from the factory, if it cannot be sluiced away, can be run off on similar rails in tipping wagons. For the bales of sisal the same trucks as used for the leaf can be employed.

By installing main lines, with subsidiary portable branch lines, a large cutting area can be served by a comparatively small length of track, and the distance over at which the natives cutting the leaf have to carry the leaf to the nearest truck is reduced to a minimum.

It is true that the capital cost of putting down light railway equipment in the first instance may be an obstacle; but it has been amply proved that when this is done the reduction in handling charges and the regular supply of leaf to the factory, to give it a steady output, shows a great reduction in the cost per ton of finished sisal. Apart from this, the quicker and more regular transport of the fresh leaf to the decorticator greatly facilitates that process and helps the machines and the workers to produce the maximum amount of sisal per ton of leaves per hour and per day.

* * * *

The foregoing figures of cost are based on British materials delivered f.o.b. U.K. port. If, however, cost has to be considered first and prices have to be cut, Continental materials could be supplied at somewhat lower prices, although, particularly for trucks and locomotives, the British materials are well worth the difference in price, and should prove more economical in the long run.

We discussed facility and economy of transport on the estate and the ideal layout of the factory to bring this about, urging that an estate of 2,500 acres, arranged 50 by 50 acres with the factory in the centre would mean the shortest possible "run out" or "run in," with the trucks laden with leaves, on either side, to any portion of the plantation, but Mr. Theakston pointed out the layout of the lines round the factory is difficult to discuss generally, as it is very seldom that the factory can be placed in the centre of the actual growing area, or that the growing area is evenly divided up into squares. Generally speaking, the factory is placed somewhere on a river, and the sisal areas are in irregular-shaped blocks, situated at varying distances from the factory.

SISAL CULTIVATION.

Discussing the cultivation of this crop, with the London representative of Messrs. John Fowler and Co., Ltd., of Leeds, I was told that sometimes the planters consider sisal to be a crop which will grow with very little, and in fact with practically no cultivation, before the suckers or bulbils are planted, and that on new estates being opened up, very often the scrub and trees are removed simply by cutting them down, very little grubbing up of the roots being carried out.

Yet the stumps thus left are a great hindrance to an adequate and especially to an economic cultivation of the crop later on, for when such cultivation is put in hand the mischief of first not clearing the land soon becomes apparent since, although all planters realize that it is necessary during the growth of the plants to work the land between them, yet when the implements used for this work encounter the obstacles

left behind, either they are broken or injured, or else in trying to avoid them the young plants often get cut and damaged; in any case, the operation instead of being an easy one, becomes tedious and costly and is never properly carried out.

With a crop like sisal which remains in the ground after being planted for at least seven years, it would appear to be obvious that a good cultivation of the soil before planting must increase the length of leaf when cutting, and tend to bring the plant to maturity earlier than if no cultivation is done at all, whilst the better the cultivation the stronger will be the plant, for the more plant food can it gather unto itself. Sisal estates have been inspected where it has been almost impossible to harvest the leaf owing to the fact that the area has practically been allowed to go back to jungle. This again is largely due to the evil of leaving the stumps and roots of bushes in the ground when the first clearing of the land was carried out. The tendency is that when the land is mainly growing jungle in this way, to leave that portion of the estate alone and instead of clearing it for replanting, to open up fresh land instead. This, however, is a very short-sighted policy, as it must cause the sisal fields to go further and further away from the factory, and so cause needless transport charges and waste of time to result.

In order to do really good clearing and reclamation work on the land required for planting, and also to carry out cultivation that will benefit the crops for reasons mentioned above, it is necessary—some people say unfortunately—to employ what most planters consider to be very expensive machinery, but before they pass such judgment they should ask themselves questions like the following: Is it really so expensive in the end? When the seven years or

so have passed, will you still not have a useful machine worth plenty of money, whilst your working costs have shown a considerable saving during the years that the machine has been used? It is only fair that such questions should be asked and answered because there are many sets of cable engines working in out-of-the-way parts of the world, often operated by native labour, that have been in use for over forty years and are still at work. Where labour is good, as on the Continent and in this country, fifty years is looked upon as quite the normal of life of such machines. In face of these facts work out your annual cost for depreciation for wear and tear and add the necessary amount for a sinking fund, and still see how little the total per annum will come to over such long periods. Having done so, it is interesting to consider how this machinery can be employed economically in spite of the original cost and so prove to be a money-saving proposition in the end. In the first place, the system used for the reclamation of land, known as the cable system, has been found in many parts of the world to be very economical for the removal of stumps after the trees have been cut down, or what is preferable when possible, to pull the trees and the roots out of the ground together, and in either case the machine can later be employed in helping to collect or haul the trees, &c., to a given spot for the "big burn." The smaller scrub can also be removed by this machinery, but in many cases it pays better simply to cut down the scrub, and then use what is known as a knifer or grubber which, after the scrub and branches of the trees have been burnt and the trunks removed, tears out any roots left in the ground both of the scrub as well as of the trees. Such work is done at a very reasonable cost in view of the fact that the implement used gives, at the same time, a thorough

aeration of the soil to a depth of from fifteen to eighteen inches or more if sufficient power in the engine is available.

After such operations, ploughs of all sorts or other implements can be used on the land as there are no obstacles to damage them, and your crops can be planted in straight lines and be properly cultivated and cropped in due course at a minimum expense. On one estate in East Africa it has been found that such cultivation as is obtained by this cable system has definitely shown that the sisal leaf is ready for cutting approximately twelve months earlier than on land which had not been prepared so thoroughly. This probably is again due to the fact that, competing growth having been removed, the sisal gets all the nourishment from the soil for itself.

It may be argued that once such work is done all over the estate, this machinery has no further use, but the biggest makers of this class of land cultivator have sent directors and representatives to study the conditions on the estates themselves, or over areas where the estates are to be formed, and they assure me that they consider it to be quite feasible to adapt an implement to carry out a scheme they have devised to utilize the machinery year after year in a way that is bound to prove very beneficial to all sisal plantations large enough to employ a set of cable tackle. In any case this idea does not increase the cost of the machinery to any great extent since it merely means an attachment to one of their standard implements, that has been devised in order to bring the fields of sisal that have already poled into bearing again in a shorter time than is possible without such help. When a field of sisal begins to pole, many of the plants start doing so earlier than others, and we therefore have a situation in which a field may contain many useful leaves but is not worth cutting on account of the

number of dead plants in it. Now such a field cannot be cleared except at a heavy expense on account of the number of green boles still standing, which boles take a good deal of cutting out by hand, and this causes a field often to be left for a considerable period until practically all the plants have poled and died, and then such a field becomes all the more difficult and costly to clear.

The new scheme is that the roots both of the dead boles and of the green boles shall be cut under the ground, so that it is possible for the natives to collect both dry and green boles together into heaps, or preferably into lines across the fields for burning. At the same time, whilst this work is being done, all the weeds and young scrub should also be cut under the ground by a bar similar to that used in a thistle cutter, but of course much heavier. We now have arrived at the position when the boles and rubbish are all piled up in a way that allows them very speedily to be dried out in the strong sun, to be burnt later on. This means that the labour formerly needed to cut up the green boles can be put to other uses, which considerably lowers the cost of clearing the land.

Meanwhile remember that, in one operation, a preliminary cultivation has been carried out between the rows, and a subsoiling effected where the old boles stood, so that it is only necessary to burn the trash which has now dried out before a proper ploughing and harrowing is given to the land now freed of all encumbrances and ready for such work. Thus I consider it to be possible to bring land which has ceased to pay into crop again at least twelve months earlier than can be done if you have to wait for the green boles to die, or if you grub them out and burn them by hand according to present methods, since those with experience in the matter say that under the

present methods it takes eighteen months to complete this operation before new suckers or plants can be put into the ground, whereas under the new scheme it is expected that it will only be six months before the suckers are replanted.

On many plantations a practice has been brought into operation which cannot but prove detrimental to the growth of the plant. I am referring to the system of interplanting young sisal between the old boles, that is of putting small plants into land more or less exhausted, and which in any case has not had any cultivation, except by the hand hoe, for the past seven years, as no mechanical implement could be used between the plants in the rows. It therefore stands to reason that the new small plants are not given a proper chance of obtaining sufficient nourishment to bring about a satisfactory growth in the minimum time. Furthermore they must be overshadowed to a very great extent by the larger plants which are gradually dying, and this again cannot have a good effect on the growth of the youngsters.

Since it is a well-known fact that the longer the leaf the more sisal fibre it contains, the object of all planters must be to obtain the longest leaf possible in the shortest period of growth. Surely it is advisable therefore to eliminate all the old boles, which carry disease, overshadow the smaller plants, and if still alive are taking more than their share of goodness out of the soil, rather than interplant between these old boles without first giving the land proper cultivation.

An argument often put up against cultivating machinery on the cable system is that it cannot do inter-cultivation work. This is true, but it can be used for this heavy reclamation work with very good results, and on estates that are sufficiently large to employ such machinery for the first clearing of land and later for clearing old sisal fields, the first cost

of the actual machinery is set off by the larger crops mentioned above, and also by the length of life of the machinery employed. This reminds one that it has also been claimed that cable cultivating machinery will go out of date, but this again has been proved wrong since large numbers of machines, as already stated, although very old are still in use, and proving economical to work, and it must not be forgotten that this class of machinery is built not only in steam, but in petrol and Diesel engines, which fact overcomes the argument that there is no suitable fuel for steam engines or that the water is not good enough, or again, that the land will not carry the weight of steam engines.

In conclusion, may I say that there is one sisal estate or group of estates which claims to have reduced their land clearing operations by two-thirds of the old cost by using cable-cultivating machinery, whilst there are others who claim that they could never have cleared their lands satisfactorily without such help.

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¹ My copy came from the office of the Soc. Henequeneros, at 15, Seething Lane, Great Tower Street, London, E.C.3.

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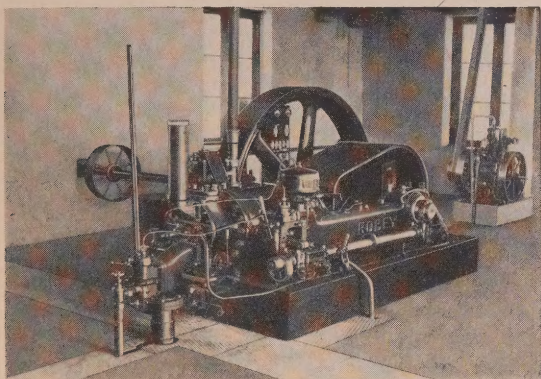
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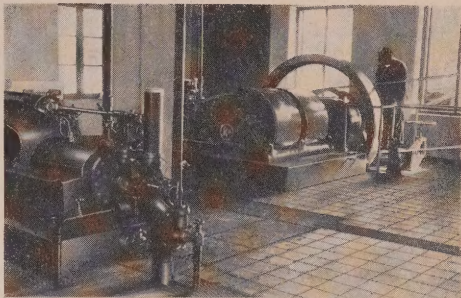
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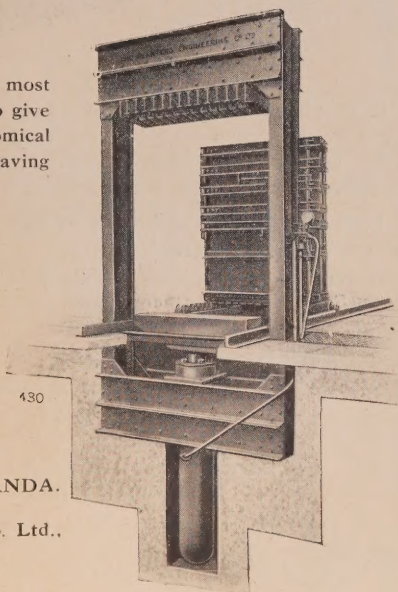
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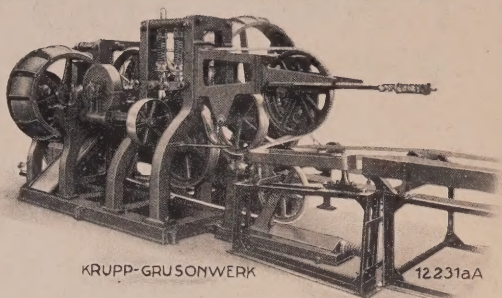
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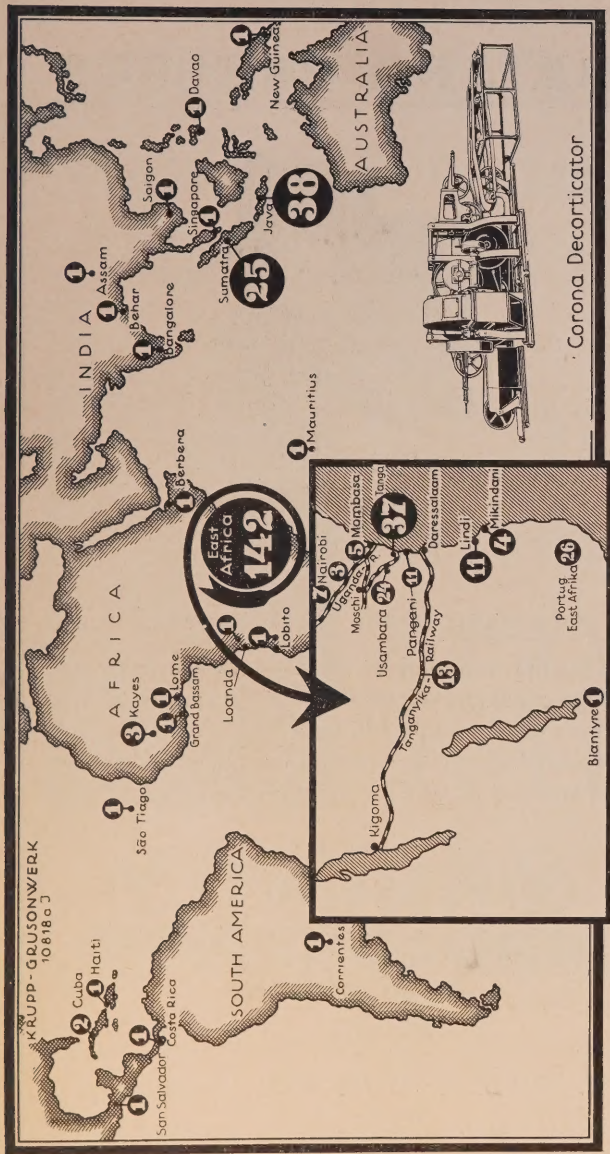
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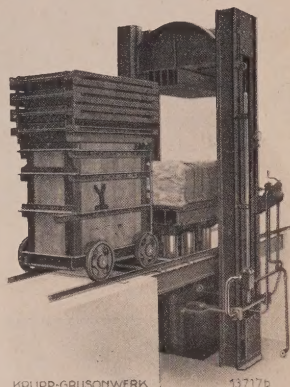
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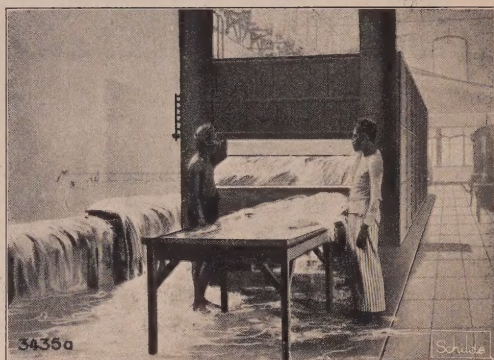
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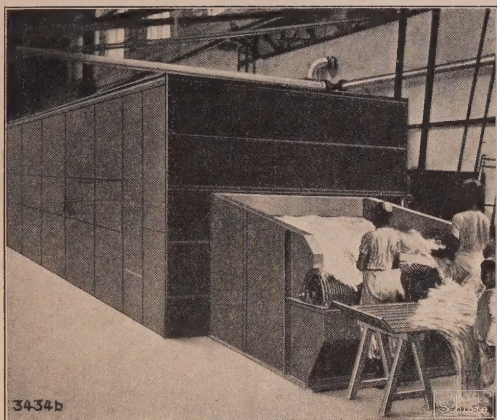
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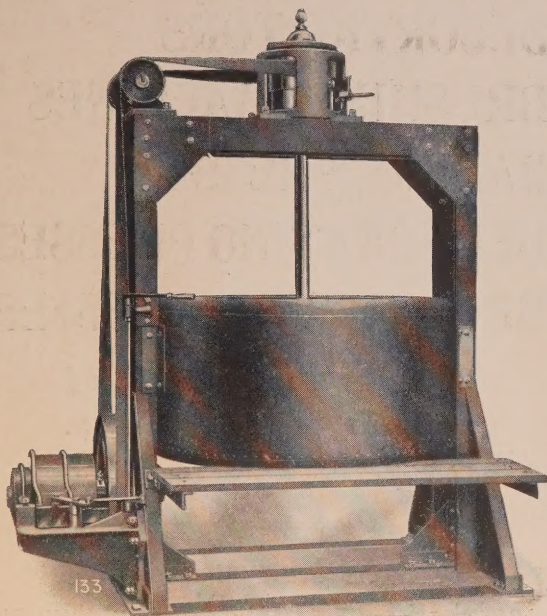


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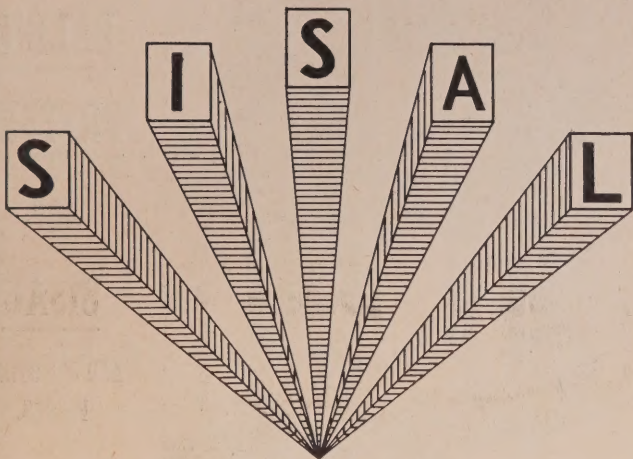
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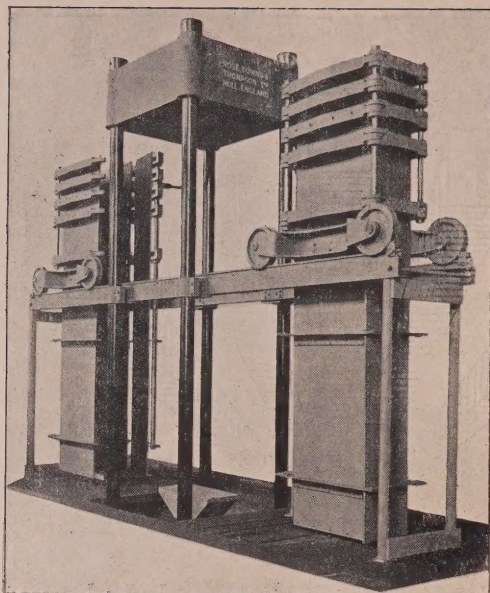
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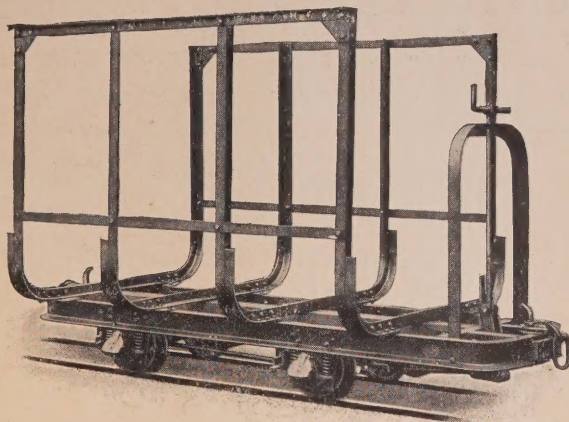
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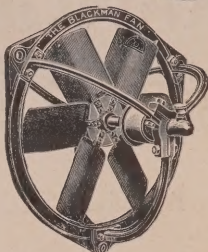
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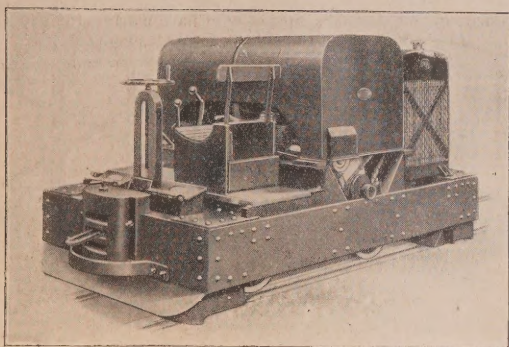
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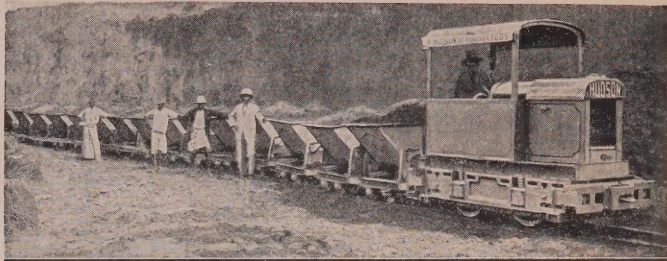
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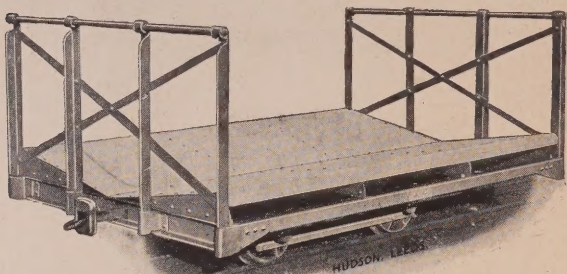
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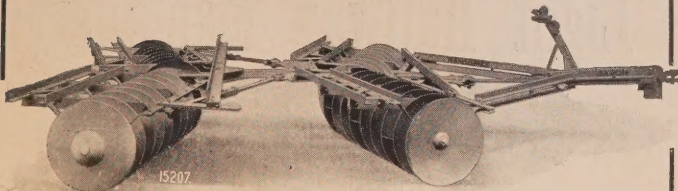


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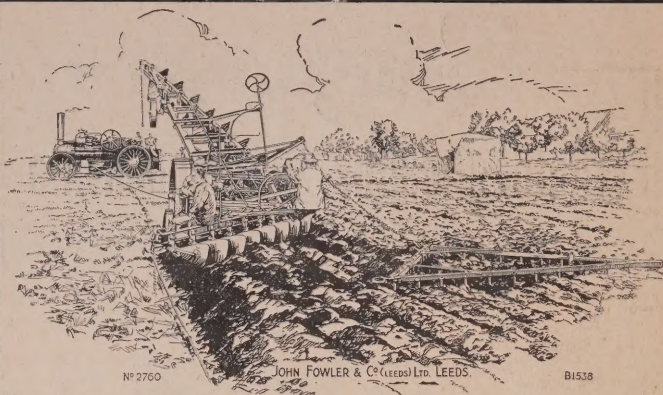
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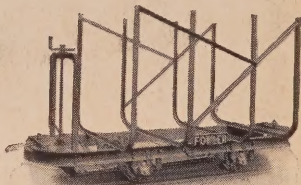
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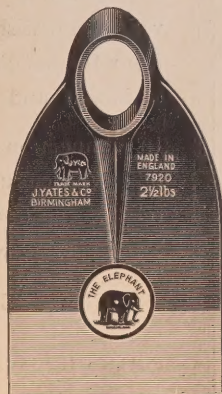
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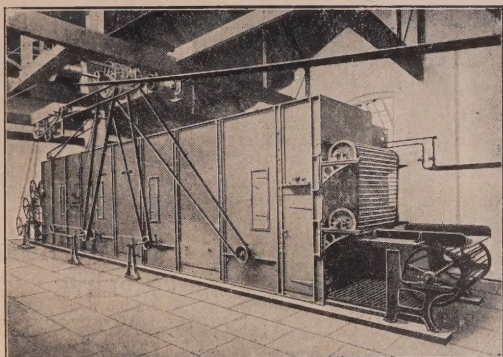
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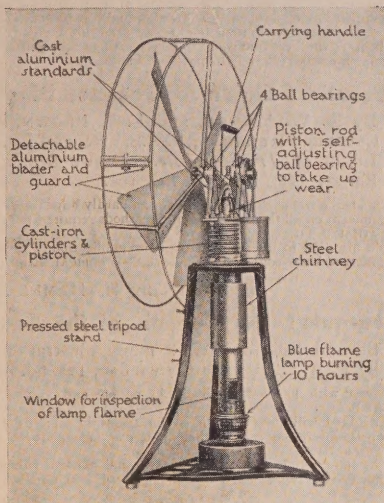
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